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APRIL 1997

BYTE

the global authority for computing technology

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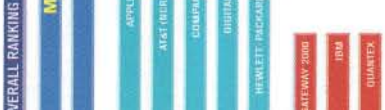

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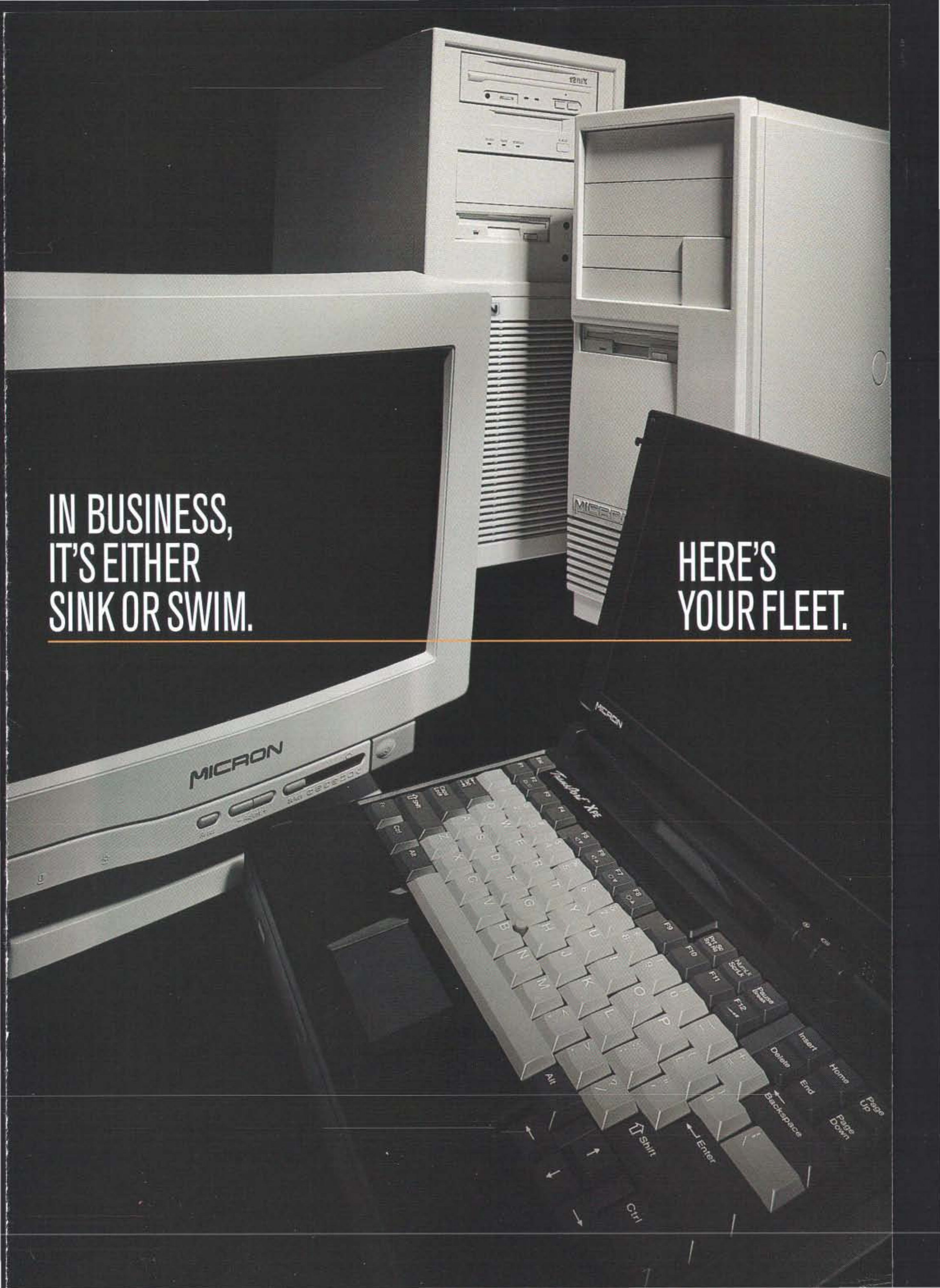
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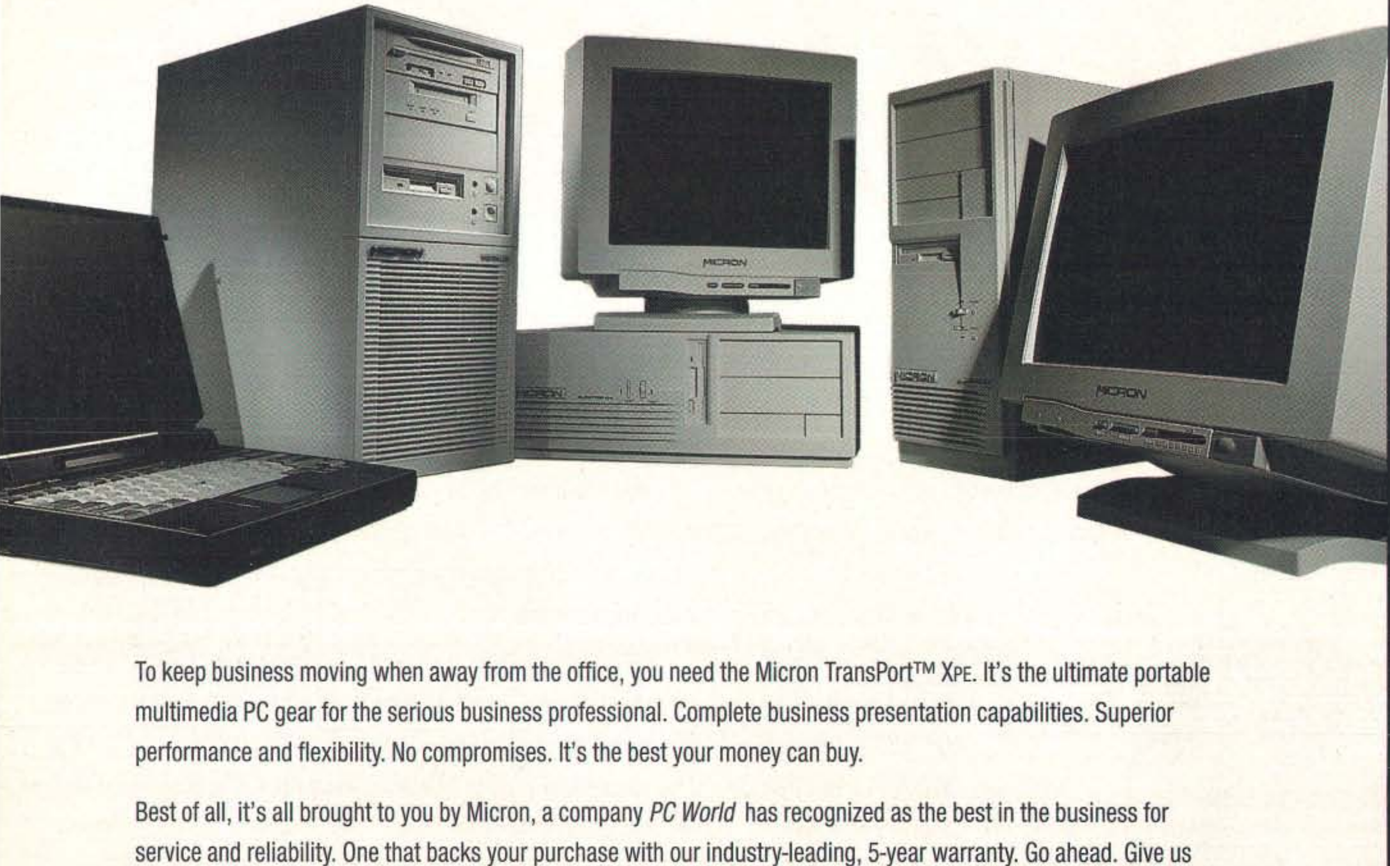

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So what does the future of the Mac® OS look like? For a glimpse, check out our newly released Mac OS 7.6. It's faster than ever before—so you can start your Mac, launch applications, save files and print up to 40% faster.

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Mac OS also has the latest version of Apple QuickTime,® the industry standard for multimedia creation and delivery. And it makes upgrading easier: with one CD-ROM and a streamlined installation process.

Intrigued? Then you'll love what comes next. Because we're hard at work on the next version of the Mac OS, code-named Tempo. Right from the start you'll notice a new look, with beveled buttons, icon drop shadows and other 3-D enhancements to the desktop. Tempo will dramatically improve system responsiveness by incorporating multitasking, multi-threaded functionality and native PowerPC™ capabilities directly in the OS. So you can run multiple applications more smoothly, and launch new applications while files are copying in the background. Tempo extends our Internet capabilities with easy

The Mac OS Report. One in a Series.

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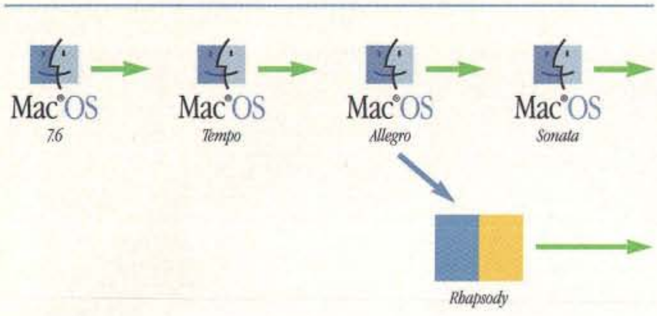

Apple's complementary operating systems – Mac OS and Rhapsody – allow you to choose the system that best meets your needs. They also allow you to decide when it's time to make the transition.

setup, personal web sharing and built-in Java.™ And it will help you be more organized, by reducing on-screen clutter with spring-loaded folders and pop-up windows for frequently used items.

Of course, Tempo also paves the way for further updates to the Mac OS. Because there's much more to come.

It will be the NeXT thing.

When we began defining a new software architecture that would take us into the future, we had two clear objectives: to enhance our traditional strengths, and to create an operating system that would leapfrog the competition, setting standards into the next century.

Enter NeXT.® By acquiring NeXT Software and adopting their kernel-based architecture, Apple can offer advanced system services such as true multitasking, protected memory and symmetrical multiprocessing. We have also strengthened our position in client-server and Internet/Intranet markets. And NeXT's object-oriented development environment and powerful tools such as WebObjects™ and Enterprise Objects Framework™ give us clear advantages in the creation of new solutions.

Merging NeXT and the Mac OS will create a next-generation OS that will give our competitors something new to catch up to. It will be an OS that helps developers create breakthrough applications by allowing greater experimentation and efficient reuse of code. It will include the best of our graphics technologies, such as ColorSync® and QuickDraw® GX. And we plan to adopt the Adobe® PostScript® imaging model as well. It will fully support the QuickTime Media Layer. It will provide industrial-strength reliability, performance and ease of use. And it will be an ideal platform for publishing, multimedia and Internet applications yet to come.

What is the name of this new OS? Its code name is Rhapsody.

It will be an Apple thing.

Rhapsody will leave other operating systems in the dust. But not Apple customers. To start with, Rhapsody will enhance the general look and feel of today's Mac OS interface. It will support all currently shipping Mac OS-based systems. It will run the vast majority of existing Mac OS applications by hosting the complete Mac OS on the Rhapsody kernel.

In short, Rhapsody will run your existing applications and utilities, read your files, recognize your current fonts and extensions and play your movies and sounds. Rhapsody will deliver the kind of technology you expect from Apple. The kind of technology that appeals to anyone who requires the highest performance for publishing, Internet and multimedia authoring, and scientific and technical work. The kind of technology that appeals to people who like to, well, get things done.

You can.

What does all this mean? It means you can do everything you're used to doing now, plus a few things you might not yet imagine. It means you can buy a Mac today and not worry about its compatibility with Rhapsody tomorrow. It means Rhapsody won't just be a new way to use a *Macintosh* – it will define an entirely new way to use *computers*. You can learn more by visiting us at www.macos.apple.com or by calling 800-538-9696 for information by fax.

The world's most intuitive and easy-to-use operating system will remain just that. With regular system updates and enhancements, the Mac OS will take you well into the future.

The acquisition of NeXT provides Apple with additional strengths in performance, reliability, network management and rapid application development.

Mac OS 7.6 extends Apple's leadership in graphics and multimedia by bringing together the latest versions of Apple QuickTime technologies, collectively known as the QuickTime Media Layer.

Apple intends to adopt the Adobe® PostScript® imaging model for Rhapsody and transfer the best of our existing graphic technologies, including ColorSync and QuickDraw GX.

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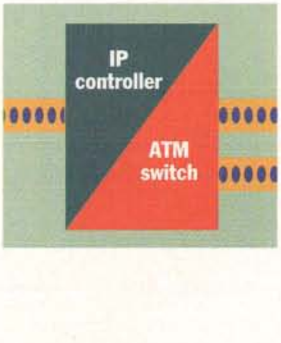

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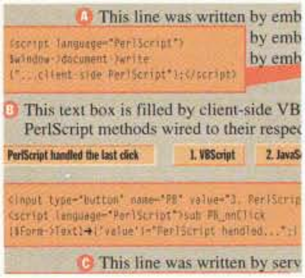

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("...client-side PerlScript");</script>
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Ⓑ This text box is filled by client-side VB
PerlScript methods wired to their respec

```
<input type="button" name="PB" value="3. PerlScrip
<script language="PerlScript">sub PB_onClick
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```

Ⓒ This line was written by serv

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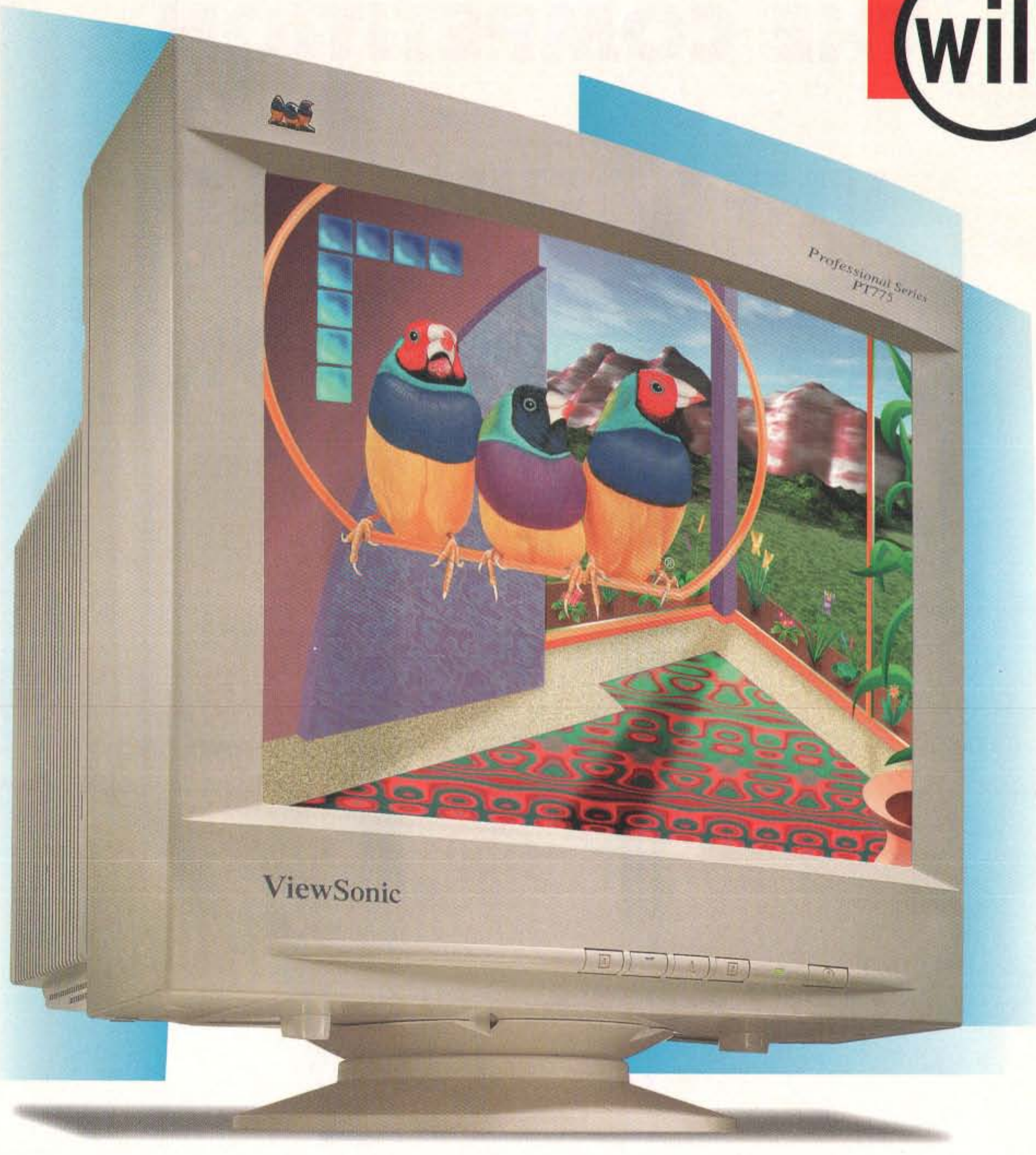

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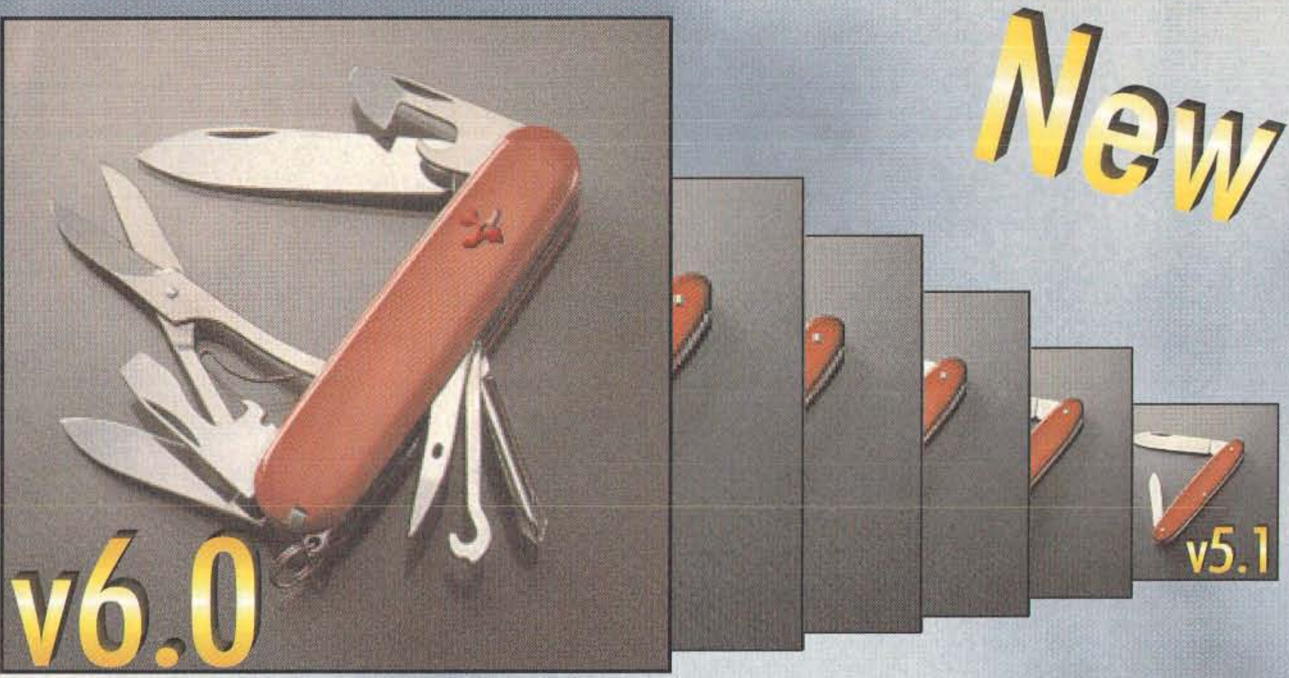

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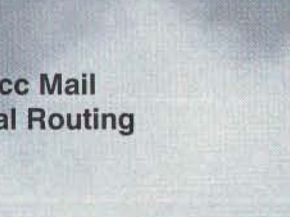

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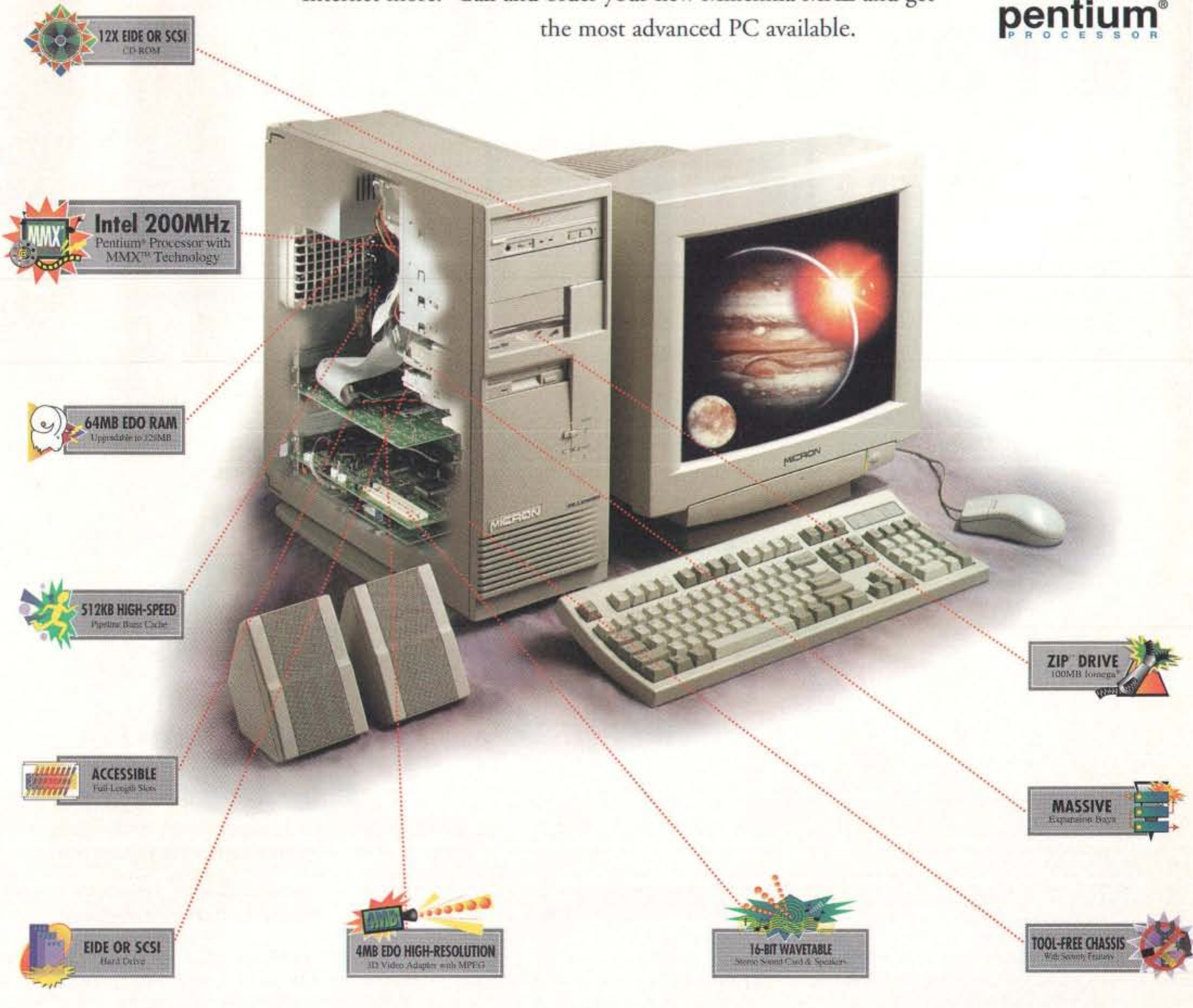

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editorial

Tracking New Technologies

We've taken a hard look at what's important to you, our readers.

This month sees some changes in the way we give you information about new computing technologies. Our research tells us that most of you are now working with computers in a corporate or institutional environment. Such an environment has its own special qualities: It's wired, it's diverse, and it requires a mixture of custom and packaged applications that work well together.

So, we've reorganized the majority of our features coverage around three tracks that capture what's most vital to business technologists: building networked applications, managing a growing amount of data, and integrating the different network infrastructures that now coexist in your companies (LANs, WANs, voice, the Internet—even video).

Let's dig into those tracks a bit. We recognize that not every application is networked. But we contend that networked applications are driving all applications development now and for the foreseeable future. The work going on in groupware development—in fundamental technologies, such as components, Java, and ActiveX—is a perfect example of that.

Our coverage of networked applications won't be limited to network or programming issues. In classic BYTE style, we'll look at the whole enchilada: what kind of servers and clients to use, how to include multimedia, and other key issues.

We will take the same approach with managing data and network integration. We will be paying more attention to DBMSes, for sure, and not just the PC desktop variety, either. But even if you aren't building a data mart or deploying query tools, you'll find interesting articles about topics such as search engines, storage, and work flow in this track over the coming months.

Similarly, with network integration, those of you who live and breathe this task will find focused articles, such as the one in this issue on integrating IP and ATM. Not a nethead? This is the place where you'll learn about the latest in computer telephony or where digital video stands.

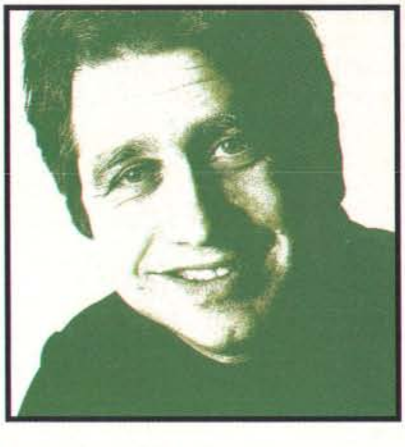
These three topics represent key challenges for the people charged with managing and implementing information technology in the next few years. We know that there are many other vital and interesting topics for us to cover, and we will do so. But we guarantee that BYTE will follow these three tracks consistently for as long as they matter.

Finally, our "Codetalk" column has become "Javatalk." The future of object- and component-based development of networked applications is so vital that it deserves a focal point in BYTE. Java itself, as the most broadly available platform for such networked applications, concentrates many of the key issues that technology faces. This column is not intended as a cheerleading section but rather as a skeptical appraisal of Java and Java tools, as well as of alternatives to Java (ActiveX, for example).

We'll focus on the wave of communications-intensive computing that began breaking with the Internet.

Whenever we change BYTE, many of you wonder whether we are departing from our long-standing traditions. The answer is yes and no. We continue our dedication to examining, in depth, computer technology and its practical applications. I expect we'll still be the quirky, eclectic, occasionally cranky voice that most of you love.

The real change is that we'll be more focused on the wave of communications-intensive computing that began breaking



this past year with the Internet. Expect successive waves: new kinds of computer telephony, intelligent networking, and many other wonders.

Some people say Leonardo da Vinci was the last person who could know everything known. Sometimes I think BYTE is the last computer magazine to try to write about all computer technology, from games to supercomputers. Now that our world has become too complex and rich to contain in one magazine, we have to focus.

But we'll continue do that from the technology standpoint, something many other publications have eschewed in favor of pure business or product coverage. We will be proud to be the last one standing when it comes to that dedication.

Mark Schlack

Mark Schlack, Editor in Chief
mschlack@bix.com

PHOTOGRAPH: KELLIE WALSH © 1997

"Five out of five stars"
BYTE Magazine, Dec. 1996

A MEETING OF THE MINDS.

SPARCplug™ PC from ROSS is the ultimate hybrid: Powerful Unix and Windows NT hardware, all in the same box.

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But don't take our word for it. BYTE magazine recently gave the SPARCplug five out of five stars for technology, calling it "an innovative solution to the problem of multiple OS personalities."

Use it as a departmental Inter/Intranet server, a cross platform software development tool for Java applications, or simply a workstation that connects to the enterprise NT environment. With SPARCplug, applications are limited only by your own brain(s).

BEST OF BYTE COMDEX Spring '96
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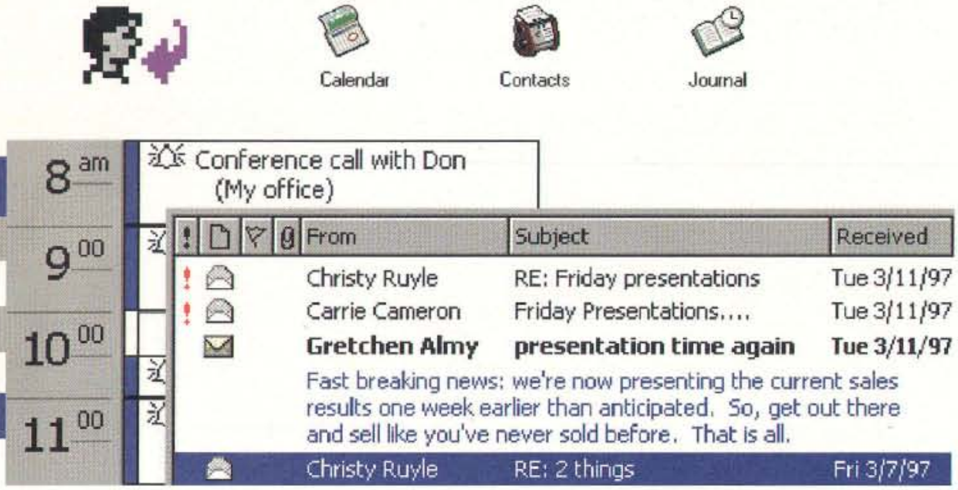

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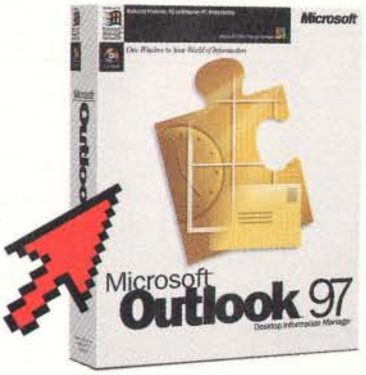

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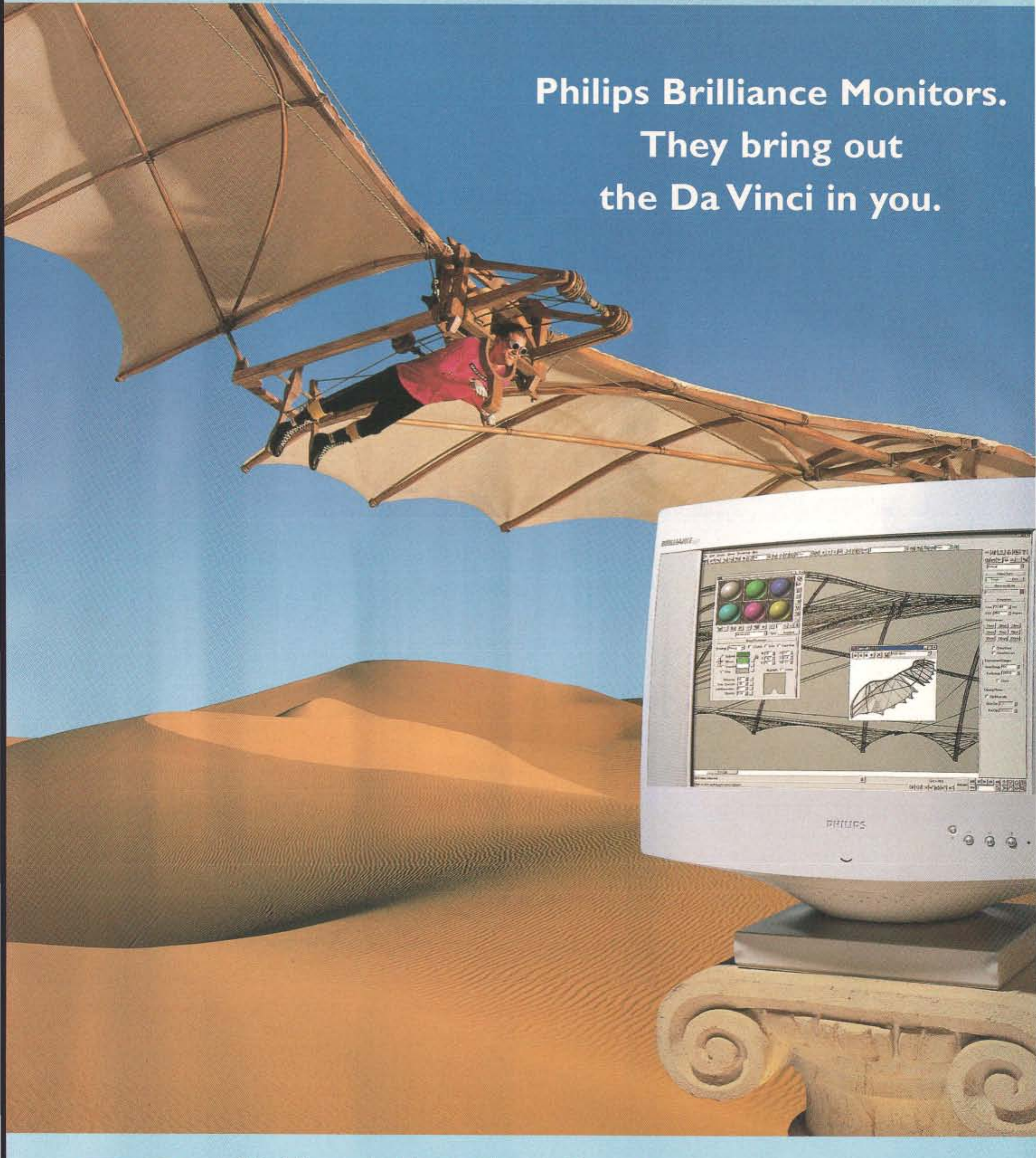

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The Right Approach

Your position on Java, Network Computers, and the need for plurality in the industry ("Living Dangerously," January Editorial) is right on the mark. Thank you for a rational article.

Richard Jacox
NetSolve LC
rjacox@exis.net

We've Been Here Before

Net PCs are neither new nor are they going to become popular in the foreseeable future. My reservations stem from my work with X stations under Unix. So-called diskless workstations have been manufactured for years. While they are useful in some narrowly defined instances, for the most part, the network load they represent is unacceptable, especially when they're used for general-purpose computing. Think about it: The average hard drive has a potential transfer rate of hundreds of millions of bits per second and latencies measured in the sub-10-millisecond range. Popular software is based on the assumption that this bandwidth is available. Ethernet has a base transmission bandwidth of tens of millions of bits per second and latencies in the best case of tens of milliseconds—1000 times slower. Also, it must be shared among all users on the network. Until we have a network access system that is at least two orders of magnitude faster, NCs simply won't have the performance the average user expects.

Steve Booth
bcs@cerf.net

X terminals and their close cousins, ICA terminals for Citrix multiuser Windows NT, load and execute applications on the host; only screen graphics execute on the desktop. Oracle-standard NCs, on the other hand, do load applications over a network and execute them locally. However, NCs won't necessarily suffer from the problem you describe, either. For one thing, they'll often find their niche in client/server environments where the client-side application is relatively small. Second, desktop applications written as components in object-oriented languages such as Java don't have to load megabytes of code into memory all at once. Parts of the program can load only when needed. Finally, NCs can optionally cache programs on local hard drives or in RAM. I've seen some prototype NCs that trickle power to RAM even when switched off. When you switch them back on, they come to life instantly, and your previously loaded programs are waiting for you.—Tom R. Halfhill, senior editor

On Java

First, you claim that Scott McNealy (Interview, January Bits) said that Java "is not object-oriented," but "object-based." I cannot believe he said that. Java has at least two important flaws, but a lack of object orientation is not one of them.

Hand-Held Windows Shoot-Out
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NetWare and the Web
8 Web-Authoring Tools Span Every Need
CaN JAVA REPLaCE WiNDOWS?
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"Today the Web, Tomorrow the World" (January Cover Story) also misses the main point. The Java virtual machine (VM) is not terribly important. People have been building VMs for around 30 years. The important thing about Java as a development platform: OS-independent API calls. The question will be how many of the facilities of the underlying OSes are accessible in an OS-independent manner. Perhaps the programs will have to be written against an API that implements the intersection of the features on the various OSes. This might not be a bad thing, but it would tend to produce a Java look and feel rather than a Windows, Motif, or Mac look and feel. In this sense, there is some justification for your cover headline "Can Java Replace Windows?," even though one is a language and the other an OS. Once the Java APIs have been invented, you can use them with any language—you just have to redo the interfaces.

Taken by itself, the article is a good report on the current state of Java. Taken with the cover headline, it is less than adequate.

David L. Moore
dlmoore@ix.netcom.com

Scott McNealy merely meant that Sun designed Java to be an object language from the ground up; it's not a retrofit like C++. You are correct that many VMs and attempts at universal platforms preceded Java. That's one reason why I believe the concept will eventually take hold, even if Java fails: It has too

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many advantages for users and developers.

Although Java abstracts the CPU and OS, it does not substitute its own look and feel. Java programs look like Windows programs when they're running on Windows, Mac programs on the Mac, and so on—without porting or even recompiling any code. Indeed, the big challenge is how many native features Java supports among the OSes it runs on. It doesn't have to support them all, however, to succeed as a "metaplatform" alongside the popular native platforms.—Tom R. Halfhill, senior editor

Ada Speaks Java

Your generally excellent article "Today the Web, Tomorrow the World" should have mentioned that using the Java interpreter, just-in-time compilers, and environment does not require you to use the Java language. In fact, the comment that "it's negligent ... to ignore the possibility that ... code may live for 10 or 20 years" suggests that today's rapidly evolving Java might not even be the best language for Java applications. An alternative, which uses a well-tested ISO-standard language designed for security and safety, is the Ada-to-Java bytecode compiler offered by Intermetrics (http://www.appletmagic.com/appletmagic.html).

Tom Moran
tmoran@bix.com

This is an excellent point that I didn't have room to cover in my January story: Other languages can target Java bytecode. You can think of bytecode as a platform-neutral mechanism for delivering software.—Tom R. Halfhill, senior editor

One Kind of Web Site

Your January issue was a bold statement of BYTE's vision of platform-independent, cross-platform computing in the future. It was a little disappointing then to read "8 Tools for Weaving Your Web Site," which reviewed eight Web-authoring programs—for Windows 95 and NT. Where was the cross-platform material here? Couldn't Unix and Mac users get a text box of possible options? Or do we have to wait for Java versions of the reviewed tools?

Jan Newmarch
jan@ise.canberra.edu.au

The article "8 Tools for Weaving Your Web Site" did not fairly portray Web Factory Pro Image 1.1. The reviewer used an early beta copy and did not mention that the $229 price included a free upgrade to Web Factory Pro Image 3.0. We would have supplied a prerelease copy of version 3.0 if given the chance. Web Factory Pro Image 3.0 shipped in November. It contains many things version 1.1 was criticized for lacking, notably site management, a GIF animator, and—since January—a price of $199. We also sell the $39 Web Factory Author, which has more features than reported in your review. Readers can decide for themselves with a free trial at http://www.tlco.com.

Stephen P. Gardner, President
Thunder & Lightning Co.
San Diego, CA

We reviewed the version that was available during our test period, and it is doubtful whether we could have substituted the version 3.0 upgrade. For the record, we omitted some features of the discontinued version 1.1 from our features table. The product did include Web-page templates, a graphics editor, and the ability to import multiple file formats. Also, as a 32-bit application, it did not run on Windows 3.1x, as we indicated.—David Essex, director of reviews

ROM vs. ROM

In "At Last: Pocket PCs That Run Windows" (January), you note that, "The MobilePro has twice as much ROM as the other two units, though the benefit isn't yet apparent." It is appropriate to compare RAM (and to a lesser extent ROM) sizes in Intel-based desktop PCs, because they are based on one processor family. However, the MobilePro is based on a Mips CPU and the other devices reviewed are based on Hitachi's SH3, making such comparisons misleading. In general, the SH3 requires fewer bytes of code than the Mips CPU to accomplish the same task. Because of this, the MobilePro may require more ROM. Code density can also affect the usefulness of the RAM in each device. If you download software into RAM, you should be aware that the MobilePro will likely use more RAM to hold the same number of programs. The larger ROM size is a tip-off.

Tim Pontius
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Wrong Slot

"Affordable 3-D Workstations" (December) included some erroneous data for the Netpower Symetra workstation tested. The graphics card was in the wrong (non-DMA) slot, resulting in a 40 percent performance degradation. The correct Viewperf performance results should have been:

DX-03	2.94
CDRS-03	9.79

The results are not impacted by the size of the L2 caches on the system processors. They were measured on the same Symetra system with 256-KB L2-cache processors, which has a street price of $10,690. This would place the Netpower system among the highest performing of the systems tested and among the lowest priced.

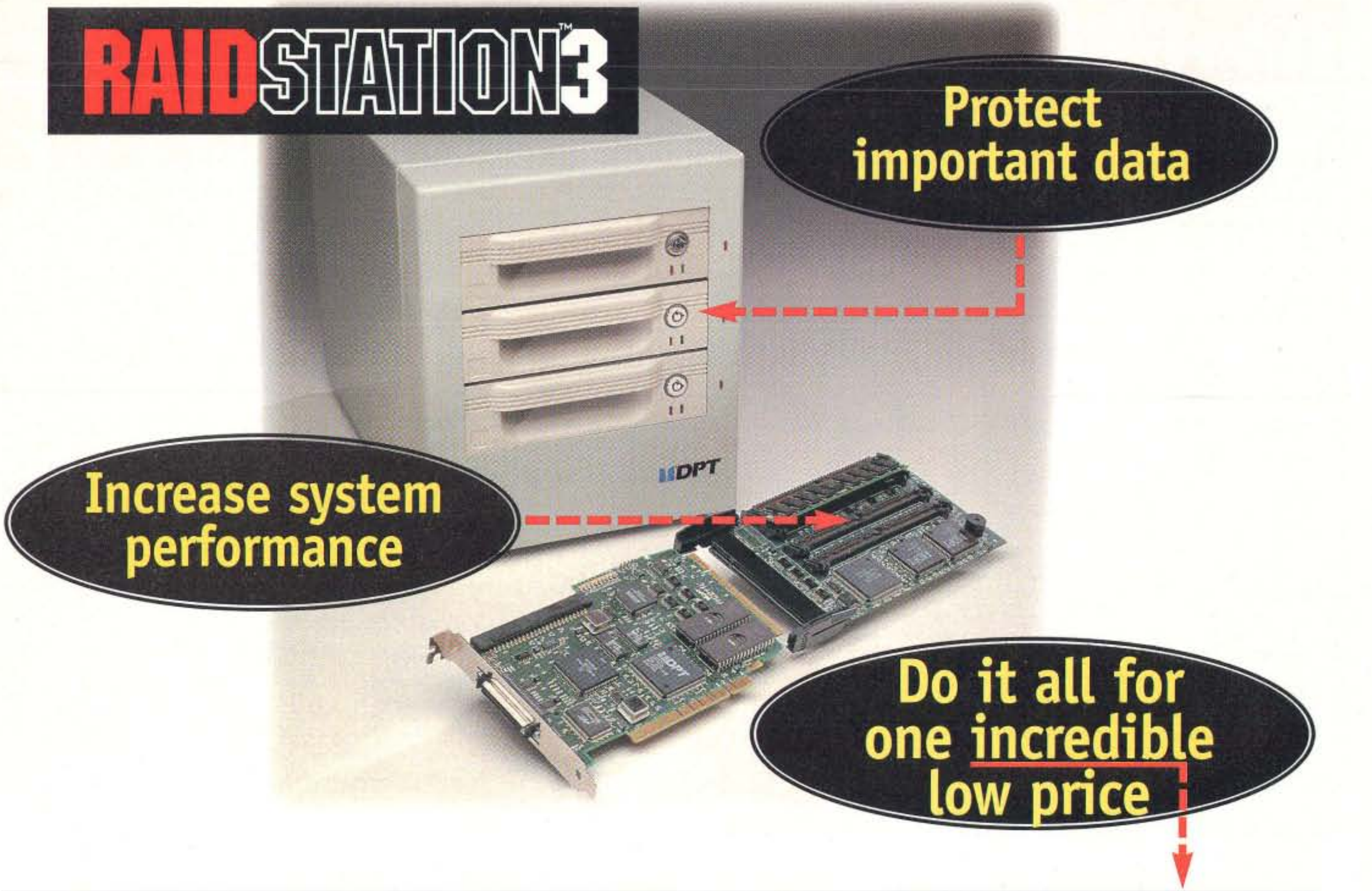
Del Hunter
Director, Technical Marketing
Netpower, Inc.
Sunnyvale, CA

We based our initial test results on an incorrectly configured system supplied by Netpower. Retesting with a properly configured system confirmed the Viewperf scores above.—Dave Rowell, technical editor

Silenced Majority?

It amuses many of the silent majority that one who confesses to supporting "impassioned, even intemperate, debate and protest" and prefers the "outspoken to agreeable" ("Peace on the Wired Planet," December Editorial) is now offended by those who take the incivility of their behavior beyond what he believes is acceptable. Rather than call for the whole "community" to exert pressure to slow this trend by those who prefer to spew rather than speak with grace, stand up as a member of the media and start a movement to clean up your own profession's act.

Louis Zednik
sczednik@juno.com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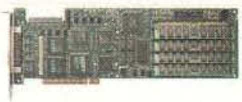

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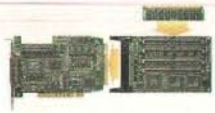

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FIXES

In "Big Screens for Big Jobs" (January), the correct URL for NSA/Hitachi is http://www.nsa-hitachi.com.

In "What's New—Hardware" (January, page 191), we inadvertently ran a photo of a Tektronix Phaser 600 in place of the Mutoh Spectrajet Hifi ink-jet printer.

"1997 Editors' Choice Awards" (January) contained incorrect contact information for Innovative Software GmbH. The company is located in Frankfurt, Germany; +49 69 236929; http://www.isg.de/.

In "All 12× CD-ROM Drives Are Not Equal" (February), we used version 1.50 of the TestaCD Labs' CD-Tach benchmark, not version 1.1 as stated. Also, TestaCD Labs' phone number is (408) 435-8773.

COMING UP IN MAY

COVER STORY

Windows NT 5.0

Our early appraisal of the next revision to Microsoft's enterprise OS focuses on new server-side capabilities. Get a first glimpse of NT 5.0's distributed services and what it may mean for corporations.

FEATURES

Control Your Data

We'll examine new electronic document management systems and compound-document technology, as well as the latest in document repositories and evolving standards to help companies control their data in the dynamic world of intranets and the Internet.

Can We Manage the PC?

In part two of our report on reducing the costs of PCs in the workplace, we look beyond the Network Computer movement to evaluate claims by mainstream PC vendors that you can have the best of both worlds: full-function PCs and significantly lower administration costs.

Applet Security

It's so easy to download applets from the Web. How can computer users determine the safety of a program before they copy it to their hard drives, and how can they protect against rogue applets once they are on the system?

REVIEWS

SMP Intranet Servers

NSTL tests high-end four-way symmetric-multiprocessing servers for Windows NT and Unix.

IMAP E-Mail Solutions

IMAP-based Internet e-mail systems are making inroads against proprietary systems in corporations. NSTL examines packages from Digital Equipment, Fujitsu, Netscape, and Sunsoft that take advantage of IMAP's flexibility in accessing centrally stored messages.

Citrix WinFrame 2.0

A leading program for remotely accessing Windows applications takes another leap forward with "Heidelberg" CPU-clustering technology.

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CAD SYSTEMS Magazine, Aug.-Sept. '96

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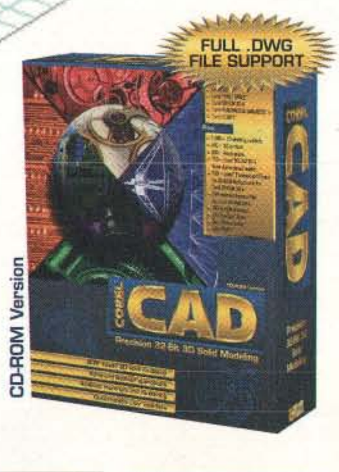

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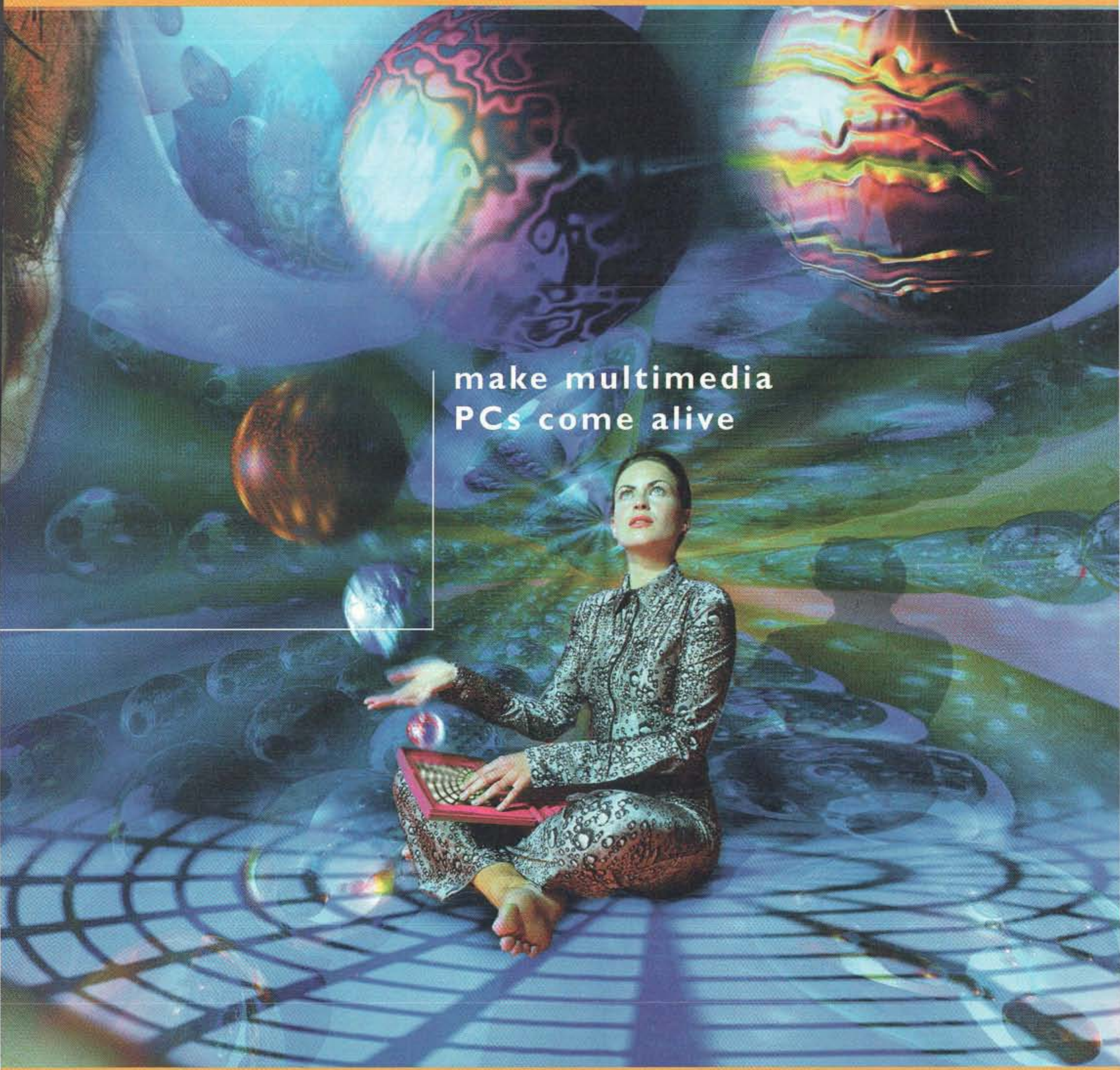

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Rhapsody with Blue

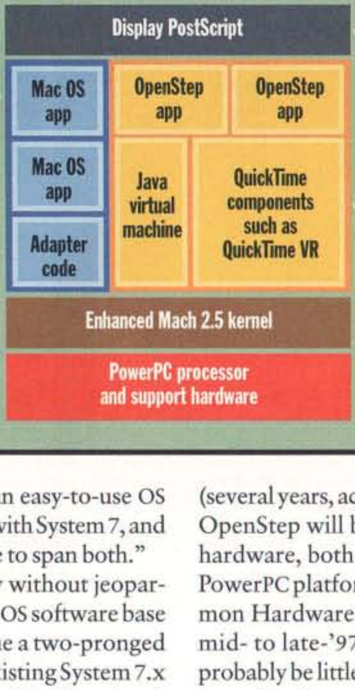
Apple's new OS strategy offers compatibility and a path to Unix and Windows.

With its next-generation operating system, code-named Rhapsody, Apple will leverage Next Software's OpenStep and other technologies to let developers write an application once and run it on many platforms. Rhapsody will use OpenStep to provide modern OS features such as a kernel, preemptive multitasking, memory protection, and symmetric multiprocessing. It will also use OpenStep's imaging engine, Display PostScript. Rhapsody will incorporate portions of the Mac OS, such as ColorSync (for color matching), QuickTime, QuickTime VR, and QuickTime 3D. The Java virtual machine will also be supported.

The new OS, which will play a crucial role in Apple's overall strategy for the future, is slated to arrive in 1998. So far, developers are encouraged. Many like what they see. "Apple is taking exactly the right pains to preserve their customers' investment, and as a leader in Mac applications, we are happy to see that," says Steve Ruddock, spokesman for Claris. Says Greg Galanos, president of tool vendor Metrowerks, "With Rhapsody, Apple now has an industrial-strength OS for server and Internet applications, an easy-to-use OS for consumer desktops with System 7, and a fantastic user interface to span both."

Getting to Rhapsody without jeopardizing the existing Mac OS software base requires Apple to pursue a two-pronged OS strategy. First, the existing System 7.x Mac OS will be supported and improved, which ensures software compatibility for Mac OS applications for the short term (several years, actually). During this time, OpenStep will be migrated to PowerPC hardware, both the Power Mac and the PowerPC platform (aka CHRP, the Common Hardware Reference Platform). A mid- to late-'97 developer release will probably be little more than an OpenStep port that lets a Mac boot into either OpenStep or Mac OS, but it will let developers begin writing to the OpenStep 4.1

Tentative Rhapsody Architecture



Backward compatibility with existing Mac OS software is achieved with the "blue box." This is an OpenStep process with a single preemptive thread that hosts the Mac OS. Mac applications still execute cooperatively, and some low-level OS code must execute in a 680X0 emulator.

Using PostScript to draw graphics and color confers visual fidelity to Rhapsody's display and other PostScript output devices.

The "yellow box" offers complete OS services such as preemptive multitasking and memory protection for OpenStep processes. Since the OpenStep libraries will be fully native, OpenStep apps can exploit the PowerPC processor's performance.

Getting from Here to Rhapsody

Developers can choose among several paths to get to Rhapsody.

Write to OpenStep. Writing to OpenStep's APIs has the advantage of getting the application onto initial releases of Rhapsody. Such applications can make use of the "yellow box" features immediately.

Write to a framework. Application frameworks manage most of the user interface and low-level chores, allowing developers to focus on writing problem-solving code. Next's OpenStep Developer tools are already available. Metrowerks will revise its PowerPlant application framework to make the appropriate calls to Rhapsody instead of to the Mac OS. Metrowerks also intends to port its CodeWarrior development tools to Rhapsody and have Objective C and Objective C run-time support available by May. CodeWarrior tools can generate x86 code, so it's possible to have such applications run on Windows NT. This route means many developers will have to learn a new API, but writing to OpenStep bestows an almost Javaesque reach for the application: Once written, it need only be recompiled to run on various flavors of Unix and Windows NT.

Write to the Mac OS. Apple will support the Mac OS for some time, but this strategy depends on how well the "blue box" imple-

geek mystique

Show Me the Money

After dropping to a low of $1.3 billion in 1991, the amount of venture capital invested in high-tech firms rose to about $5 billion in 1996, according to analysts at Venture Economics Information Services (VEIS, Newark, NJ). Software start-ups involved in the Internet, networking, and communications attracted the most attention (and money) from venture capital firms, a trend experts anticipate will continue throughout 1997. "The amount of venture capital available for software companies is definitely increasing," says Bob Barrett, managing partner at Battery Ventures (Wellesley, MA), a firm that focuses on software, communications, and the Net.

Although there are high risks and uncertainties in the fast-changing world of the Web, VC firms still hunt eagerly for the next cyberspace super start-up. And the increase in venture investments will likely mean more initial public offerings in the next few years, says Arjun Rishi, CEO of Export Software International (http://www.esi2000.com). ESI recently received $4 million from Battery to finance its line of software that helps companies doing business in international markets automate their export processes.

Due to keen competition, typically larger start-up costs, and thinner margins, hardware fledglings have for the most part fallen out of favor since the mid-1980s, says Jesse Reyes, director of VEIS, the research and investor services arm of Venture Economics. That's not to say that getting capital for a software start-up is a piece of cake: Battery reckons it invests in only one in 100 companies it interviews. But for start-ups seeking venture, software for cyberspace is generally where it's at. –Dave Andrews

API. A "Premier" release, currently slated for delivery in approximately January of next year, will feature an OpenStep user interface tailored to provide the Mac's look and feel.

The Premier release will also provide limited Mac application support through a "blue box." The blue box is an OpenStep process. It hosts a compatibility environment that will consist of a single preemptive thread that executes the Mac OS and Mac applications. It also uses a single contiguous memory space, as required by the current Mac OS architecture.

The blue box is not a virtual machine or an emulator: All the PowerPC-based Mac OS and Toolbox code executes natively, and low-level system calls are redirected to the appropriate kernel services. This means that Mac OS applications still execute cooperatively and that low-level OS services (such as the File Manager) composed of 680x0 code must execute in an emulator.

OpenStep applications execute in a "yellow box" as processes with full access to preemptive tasking, multithreading, and memory protection (see the figure on the previous page). By mid-1998, a "Unified" release of Rhapsody will provide seamless support for both Mac OS and OpenStep applications, Apple says.

A big advantage of Rhapsody is the OpenStep framework, a set of object-oriented libraries. Both the framework and the kernel have been field-tested over several years and so provide a stable foundation upon which to build Rhapsody, which is crucial for producing a reliable OS within Apple's own aggressive schedule. OpenStep is also well known for its application framework, which allows custom business-critical applications to be designed rapidly, a valuable feature for enterprise computing. The devil is in the implementation details, but the Rhapsody scheme breaks the job into independent, manageable projects.

Porting OpenStep shouldn't be difficult: The job has been done several times before: The OS has been ported to Intel, HP PA-RISC, and SPARC processors. The frameworks have been ported to Solaris (on SPARC processors) and Windows NT (on x86 processors). Technology that will provide the basis for the blue box has been done already: The Macintosh Application Environment (MAE) is software that hosts Mac OS 7.5.3 inside an X window on workstations running Solaris 2.5 or HP-UX 9.05. According to Jim Gable, vice president of marketing for Applesoft: "We've already got many of the MAE engineers working on the Rhapsody blue box." While the goal is to have Mac OS application windows appear indistinguishable from OpenStep application windows on the Unified release, it's likely that for initial releases of the blue box implementation the Mac OS will live in an OpenStep window, similar to MAE. Modifying OpenStep to inherit the Mac's look and feel shouldn't be difficult since the UI objects are decoupled from the rest of the class libraries. According to Fredric Bonnard, product manager for OpenStep, "Moving to Rhapsody shouldn't be difficult. The major issues will be integrating the Mac technologies with OpenStep and the trade-offs in the UI between the Mac OS and OpenStep."

Rhapsody's support for multiple development paths means that when you write a Mac OS application, you'll no longer write for a single platform. Instead, the program has the potential to be used on Unix and NT platforms. This "write once, run many" scheme is what made Apple's QuickTime the de facto standard for multimedia work, since it runs on Macs, Windows PCs, and SGI workstations. The potential for writing a program that runs on all computers—whether Macs, NT PCs, or Unix workstations—is perhaps Rhapsody's biggest benefit.

–Tom Thompson

mentation is carried out. Metrowerks recently acquired the Latitude Group, which owns a porting library that enables Mac OS applications to operate on Unix systems such as Sun's Solaris 2.3, SGI's IRIX 5.2, and HP-UX 9.03. This porting library reroutes Mac OS calls to the appropriate Unix services. Metrowerks will rework the library so that it interfaces with Rhapsody. This should enable developers to continue using the Mac OS APIs, and the resulting applications will benefit from Rhapsody's advanced capabilities.

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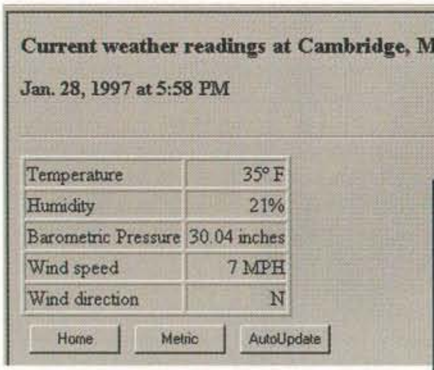
Let's Get Small

Though embedded systems have long been featured in consumer products, many remain notoriously difficult to use. For proof, you need look no further than the fact that the most technologically advanced society in history includes many people who own VCRs that forever blink 12:00. This, however, is about to change.

Recent advances by major players in the arena of embedded operating systems portend a swelling population of appliances, remote sensing devices, and television sets that you'll be able to easily access from the World Wide Web using a browser.

Making embedded devices accessible through the Web elegantly removes the main barriers to their widespread exposure in consumer products: lack of an easy, standardized way to interact with embedded software and the absence of a standard mechanism for upgrading software after devices are deployed.

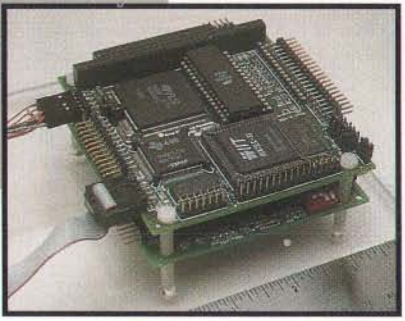


Current weather readings at Cambridge, Massachusetts

Jan. 28, 1997 at 5:58 PM

Temperature	35° F
Humidity	21%
Barometric Pressure	30.04 inches
Wind speed	7 MPH
Wind direction	N

You can view data from Phar Lap's tiny weather station at http://smallest.pharlap.com.



At the upstream end of this phenomenon are companies that have long specialized in creating embeddable OSes for high-tech industrial and military applications, including Phar Lap Software, Integrated Systems, Microtec, and QNX Software Systems.

Phar Lap (617-661-1510; http://www.pharlap.com) recently introduced its TNT Embedded Toolsuite, a package that allows designers to create embedded applications using standard Windows workstations for developing, testing, and debugging. To help promote the concept of using the Web to interact with embedded devices, Phar Lap built a small weather station (it measures just 3.6 by 3.8 inches) using its TNT Embedded Toolsuite (real-time edition) and the Weather Monitor II from Davis Instruments.

The Phar Lap tools construct their solution around the Win32 API, making them inherently compatible with the tens of millions of Windows 95, Windows 3.1, and Windows NT computers deployed worldwide. "It's a Windows world out there," says Phar Lap president Richard M. Smith, explaining his company's decision to use the Win32 standard rather than a proprietary solution.

By contrast, QNX (613-591-0931; http://www.qnx.com) offers developers a Unix-oriented toolset that features a miniaturized GUI component that resides in less than 1 MB of RAM. Together with other system software components and application data, the run-time footprint of QNX embedded systems is less than 4 MB. "You can implement full-featured Web browsing capability using small amounts of flash memory, RAM, or ROM using our tools," says QNX spokesman Greg Bergsma. QNX has announced a partnership with TV set-top box maker Welcome to the Future, which uses QNX technology to implement an "Internet Channel" capability that will be marketed by cable companies.

In the niche of high-reliability applications, Microtec (408-980-1300; http://www.mri.com) markets a tool suite that includes a proprietary real-time OS, compilers, and debuggers, which developers use to invest devices with sophisticated remote diagnostic capability. Code for the Microtec embedded Web server resides in an astonishingly compact 16 KB, not including embedded application Web-page data. Microtec has a substantial presence in high-reliability, x86-based applications in the transportation, med-

future watch

New LCD Challenger to Arrive Around Year 2000

Field emission displays (FEDs) may one day replace both LCDs and bulky CRTs, but don't expect them to pose a major threat to current desktop display technologies before the year 2000.

There are several approaches to FEDs, but the general idea is that individually addressable electron emitters, arranged in a grid, are sent electrical signals that cause electrons to flow, react with a phosphor screen, and generate colored light. FEDs promise low power requirements, wide viewing angles, a much thinner profile than today's bulky CRTs, and high-quality images.

Several companies are working on FEDs. Candescent Technologies (based in San Jose, CA, and formerly called Silicon Video) expects to begin first production runs of its FED in 1998. Company officials say you should start seeing notebooks with its FED screens in 1999. The company is now in the phase of testing where it analyzes issues such as the ability of its screens to work under various temperature, vibration, and other conditions.

Candescent's FED will offer image quality that's better or equal to a CRT, a wide viewing angle, and better video response and color representation than an LCD. But other companies are working on smaller, monochrome screens for test and measurement devices and cockpit displays. For example, PixTech (Montpellier, France, and Santa Clara, CA) has already entered pilot production and expects to enter volume production of its 5.2-inch monochrome FED. A color version is expected this year.

David Mentley, vice president of display research for Stanford Resources (San Jose, CA), a market research company specializing in electronic displays, expects FED implementations for hand-held and communication devices to follow the displays for test and measurement equipment. FEDs will provide a strong challenge to 12- and 13-inch LCD notebook displays within three to six years, he predicts. –DA

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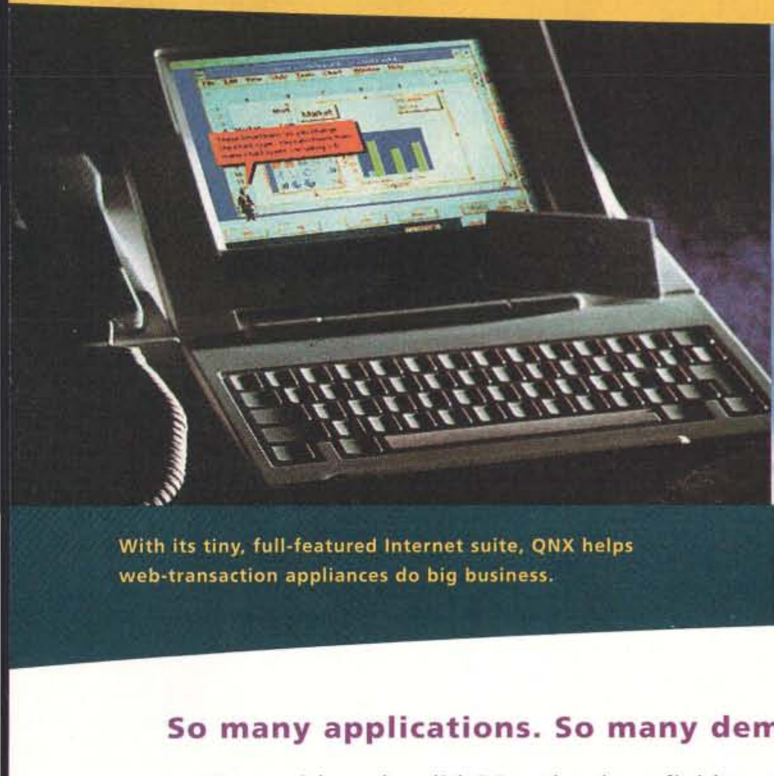
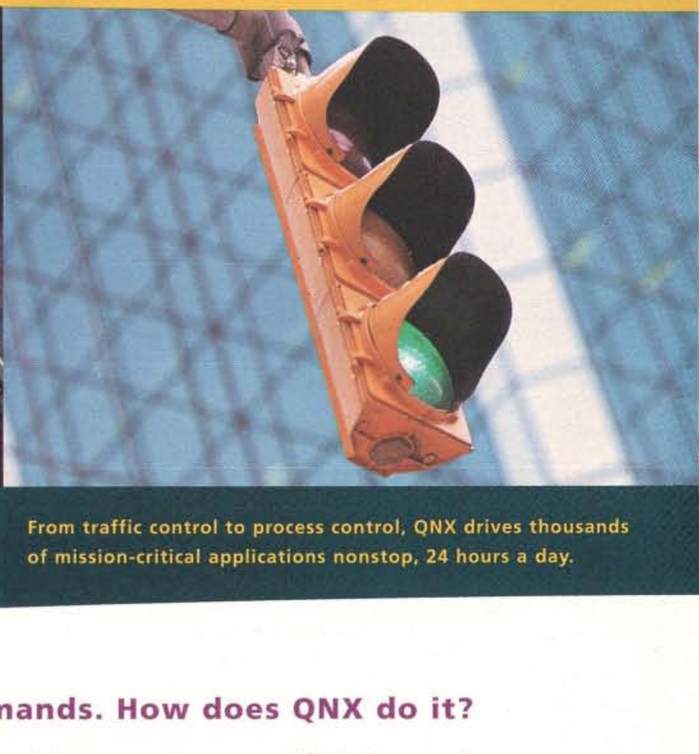


With its tiny, full-featured Internet suite, QNX helps web-transaction appliances do big business.



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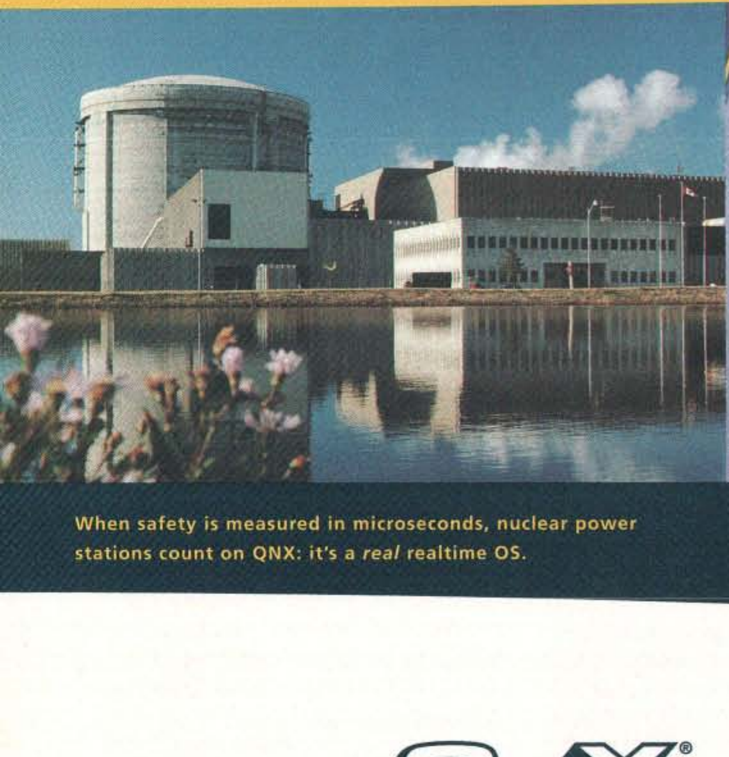

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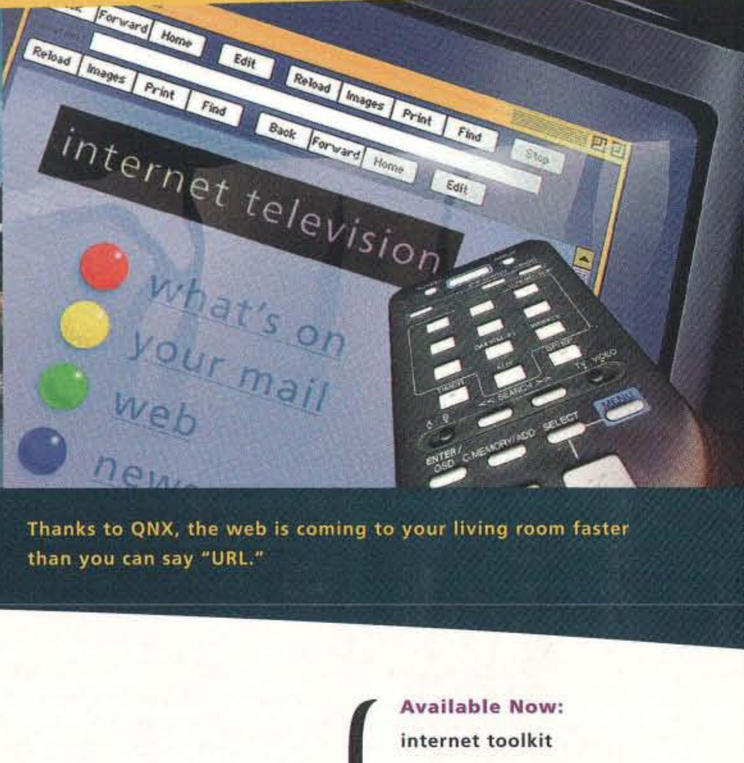

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ical, and communications fields. This hints that many of these devices will migrate to the Web fairly quickly, since a simple and inexpensive mechanism for handling remote diagnostics and software updates could significantly reduce the cost of owning and operating complex instrumentation.

"It's not that we couldn't remotely access these devices before," says Paul Rosenfeld, manager of Microtec's PCx86 business unit. "It's just that HTTP confers the benefits of standardization when we access the devices and transfer data to and from them. Now anything that can run a Web browser can access embedded devices."

Integrated Systems (ISI, 408-542-1500; http://www.isi.com) initiated its move toward embedded Web server technology when it introduced its embedded HTTP server about a year ago. The ISI OS and tool suite are at the heart of Philips' new smart TV and several upscale models of Ungermann Bass datacomm equipment. In addition, ISI tools are currently in use in more than 50 unannounced embedded Web server projects, with about half of those under development by major multinational companies in the U.S., Europe, and Japan, ISI officials claim. Speculating on what has driven vendor interest in embedded Web technology, ISI vice president of marketing Greg Olson says, "We finally have a universal user interface." In a significant break with the past, this universal GUI should help result in embedded systems that require little or no training.

–Nancy Nicolaisen

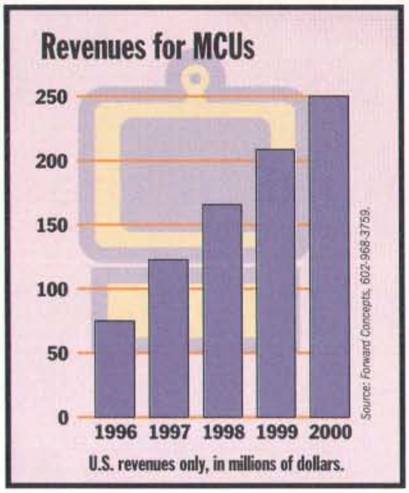
Video Streams for More Than Two

It takes a desktop videoconferencing user about a day to figure out that to truly be productive with this technology, a system needs to support far more than one-to-one conversations. Enter the multipoint control unit (MCU), a bridge that connects with three or more users, interprets their audio and video, and sends back an audio and video data stream. But there isn't just one "standard issue" MCU any more. Nor, by the way, is a live network broadcast limited to TV sets.

The multipoint market is expanding rapidly. The 1997 Teleconferencing Markets and Strategies report from Forward Concepts (602-968-3759; http://www.fwdconcepts.com) says the revenues generated from sales of MCUs alone (this figure doesn't include MCU services) will climb to $250 million by the year 2000.

For H.320 desktop video system users, the MCUs are more reliable, more user-friendly, and are becoming less expensive. For example, VideoServer (617-582-8500; http://www.videoserver.com) sells its entry-level, four-user MCS Series 2000 Model 2007 system (expandable to eight users) for $22,550. Upgrades for the system include a continuous-presence module (lets you see all participants at once), an audioconferencing module (supports an audio-only participant), and a premise-switching module. These modules fit into the MCS chassis and add value incrementally. MultiLink (508-691-2100; http://www.multilink.com) takes a different approach. The company's System 80 uses programmable DSPs to ensure flexibility in all components. Where a VideoServer customer would purchase a separate continuous-presence module, for example, a MultiLink customer would download and install software to gain that functionality.

Lucent Technologies (908-582-8500; http://www.lucent.com), another leader in the multipoint conferencing market, has focused on ease of use. George Ralston, Lucent's visual communications strategic marketing manager, emphasizes that multipoint systems are more foolproof than ever. "People want to have more access and control over their conferencing experience with less specialized training," he says. That means replacing current MCUs managed by a human with consoles that conference participants manage themselves via touchtone telephone interface or graphical PC user interface, Ralston says.



Revenues for MCUs will increase along with acceptance of videoconferencing.

For those sending video around the Internet or an intranet, nothing's guaranteed, nor is setup and configuration for the faint of heart. But real-time IP multicasting with proprietary and standard-compliant protocols keeps getting better. IP/TV, from Precept Software (415-845-5200; http://www.precept.com), is a standards-based integrated client/server software-only solution for private or public, real-time or store-and-forward video viewing (NT server costs $1995, Windows

Bug of the Month

ATM Woes Strike Acrobat 3.0

I use Adobe Acrobat on a daily basis, so I was excited to finally hold the shipping version of 3.0 in my hands. However, after I installed the newest Acrobat, my Power Mac began crashing, mostly when printing, but also seemingly intermittently. And it began presenting me with Type 11 error messages.

Luckily, BYTE editor and resident Mac guru Tom Thompson knew about the problem. He told me the crashes were most likely due to version 4.0 of Adobe Type Manager, which ships with Acrobat 3.0. A quick scan of Mac-related sites on the Web showed that other users had encountered the same bug. A downgrade to an earlier version of ATM solved the problem, and now my Acrobat works hummingly.

Adobe has acknowledged the situation, citing a conflict between ATM 4.0 and Apple's LaserWriter printer driver 8.4.x. The work-around at this time, says Adobe, is to switch to an earlier version of either ATM or the LaserWriter driver, or to switch to Adobe's PSPrinter v. 8.3.x driver.

–Jenny Donelan

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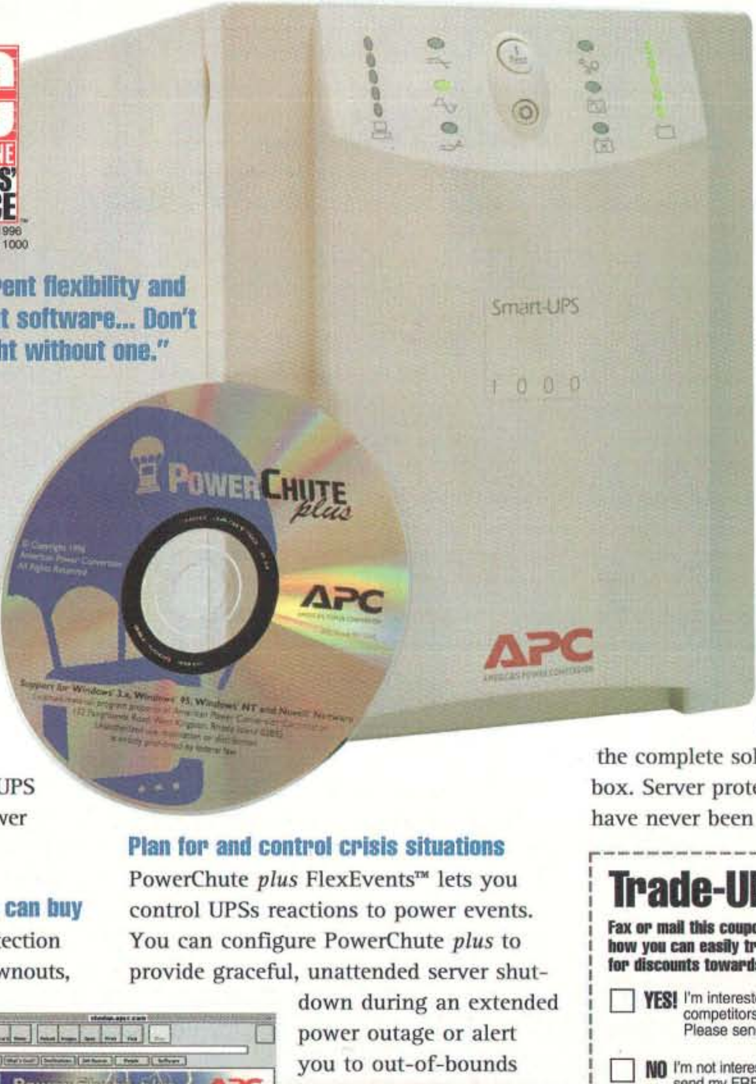

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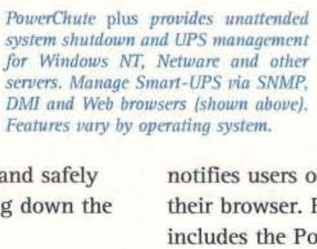

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client, $195). It requires no hardware additions or upgrades.

Another option for multiuser, LAN-based desktop videoconferencing is the TeamVision line of products from Intelect Visual Communications (212-317-9600; http://www.videoconferencing.com).

PictureTel (508-292-5000; http://www.picturetel.com) will also release special multipoint options for users of its Live-LAN (IP-based digital videoconferencing) product line.

White Pine Software (603-886-9050; http://www.wpine.com), developer of the Enhanced CU-SeeMe software for desktop video on the Internet, is most often associated with end-point software. But providing a robust multipoint software solution for the Internet is definitely part of the company's plan. Andrew Hally, director of product marketing, estimates that more than 100,000 people worldwide use the White Pine Reflector 2.1 daily for applications ranging from university lectures to casual video chat rooms.

If you are not sure about the future of multipoint conferencing, then just wait a few weeks. Before you know it, Microsoft and Intel will come out with their own versions. A multipoint, multicasting, multinetwork, multimedia conferencing solution cannot be far behind any of the new H.323 end-point products. After all, it takes most users only one day to figure out that multipoint is where it's at.

–Christine Perey

Replication Everywhere

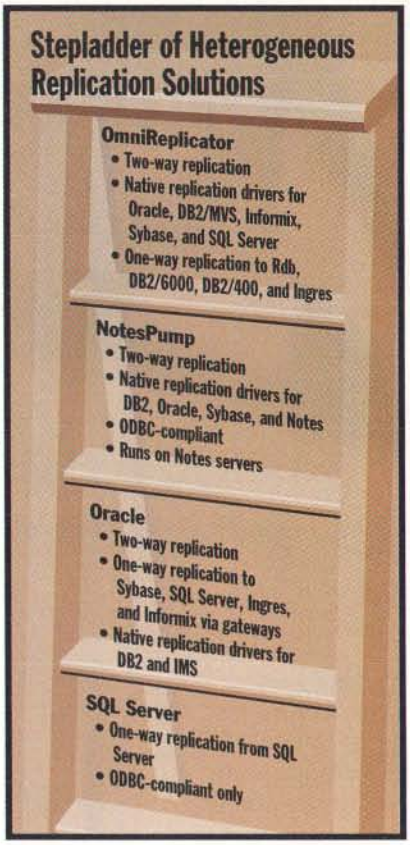
No database is an island, thanks to heterogeneous replication. Unlike replication schemes that let you replicate only amongst the same database management system, heterogeneous replication lets you synchronize data from multiple vendors' databases. The Gartner Group estimates that each Fortune 1000 organization has an average of five different database sources. Heterogeneous replication permits these database assets to interoperate with each other.

A sampling of database and third-party vendors' products shows a ladder of progressively more flexible solutions. At the ladder's bottom step, Microsoft SQL Server 6.5 (206-882-8080; http://www.microsoft.com/sql) offers replication from SQL Server to any other database compliant with Open Database Connectivity (ODBC). This opens a substantial range of options because all major databases are ODBC-compliant. SQL Server replication works just one-way. It does not support applications that require database updating on either end of a replication activity. However, one firm interviewed for this story rejected SQL Server, in part, because ODBC was slow compared to native drivers.

Further up the ladder, Oracle with Replication Services for DataPropagator (415-506-7000; http://www.oracle.com) facilitates two-way replication between legacy data and Oracle workgroup or warehouse systems. An administration tool supplies a graphical user interface for controlling replication functionality.

continued

Stepladder of Heterogeneous Replication Solutions

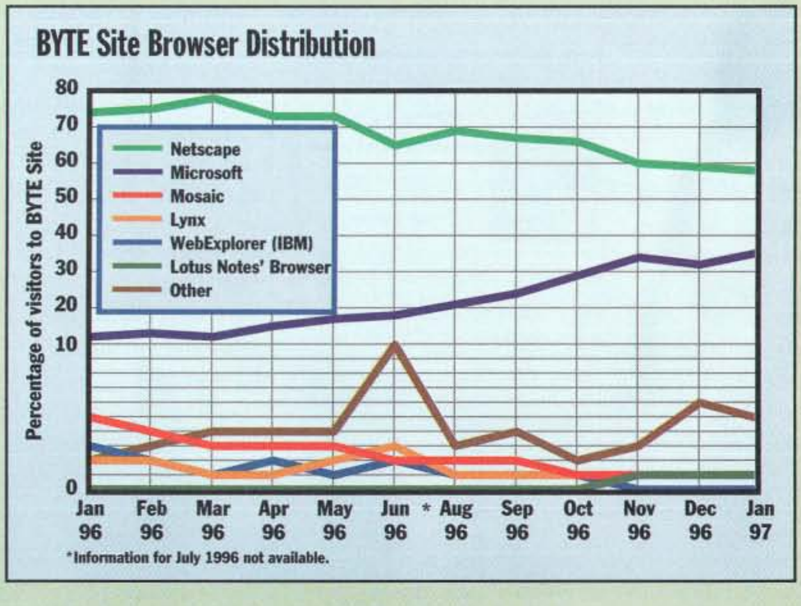

OmniReplicator
• Two-way replication
• Native replication drivers for Oracle, DB2/MVS, Informix, Sybase, and SQL Server
• One-way replication to Rdb, DB2/6000, DB2/400, and Ingres
NotesPump
• Two-way replication
• Native replication drivers for DB2, Oracle, Sybase, and Notes
• ODBC-compliant
• Runs on Notes servers
Oracle
• Two-way replication
• One-way replication to Sybase, SQL Server, Ingres, and Informix via gateways
• Native replication drivers for DB2 and IMS
SQL Server
• One-way replication from SQL Server
• ODBC-compliant only

Survey

Internet Explorer Gains on Netscape

Microsoft appears to be gaining ground in the battle for Web browser market share. According to the logs we keep of which browser people use when they view advertising banners at The BYTE Site (http://www.byte.com), Microsoft's Internet Explorer (all versions) has jumped from 12 percent in January '96 to 35 percent in January '97. Netscape Navigator (all versions) is still the most popular browser, but as the chart indicates, its market share has declined. And though our logs show it in the minority, the Web Navigator included with version 4 of the Lotus Notes client has made it onto the chart.

BYTE Site Browser Distribution



*Information for July 1996 not available.

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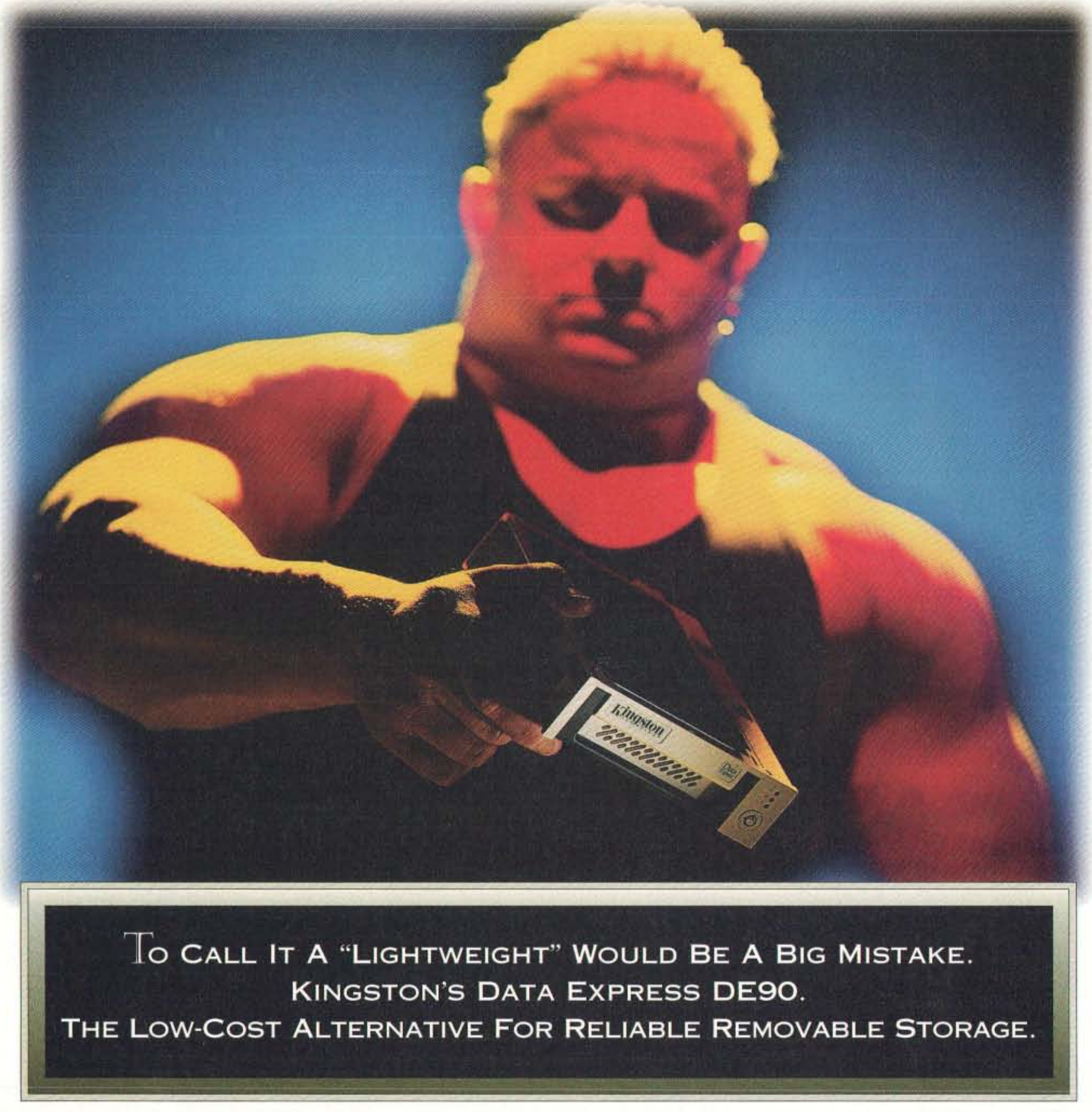

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Oracle's heterogeneous asynchronous replication functionality supports DB2 for MVS and the AS/400, as well as two-way replication with IBM's Information Management System databases.

On the next step, NotesPump 2.0, from Lotus (617-577-8500; http://www.edge.lotus.com/pumpzone/index.html), provides replication services through the use of native drivers, ODBC, and the IBM DataPropagator. Databases with a native driver link include Oracle, Sybase, and Notes. The DataPropagator route permits replication with IBM DB2 legacy data. NotesPump's data transfer is bidirectional, and the program's Administrator provides a graphical interface for scheduling replication activities on a regular schedule or in response to specific conditions in a Control Store (a Notes database). The NotesPump Server reads and executes commands from this database.

OmniReplicator, developed by Praxis International (617-622-5751; http://www.praxisint.com), is at the top of the ladder. It supports bidirectional replication among DB2/MVS, Oracle, Informix, Sybase, and SQL Server. OmniReplicator also permits one-way replication from any of these databases to a set of other databases, including Rdb, DB2/6000, DB2/400, and Ingres. Karl Fonda, leader of the data management center of expertise at Eastman Kodak, asserts that OmniReplicator best fits his company's replication needs because it supports a wide variety of heterogeneous database types. OmniReplicator can help replicate even between applications written by different versions of the same DBMS family. For example, Informix recommends OmniReplicator for synchronizing applications written with different versions of the Informix DBMS.

Which type of product best suits your heterogeneous replication needs? If you require only one-way heterogeneous replication and budget is an issue, then SQL Server may be the best solution because replication is built into the program. Shops with deep Oracle talent and a need to link to legacy data may find Oracle's offering is best. NotesPump offers a wider range of options than anything on the first two steps of the ladder. NotesPump has special appeal to shops experienced at setting up and managing Notes servers. OmniReplicator has the most extensive range of replication services.

–Rick Dobson

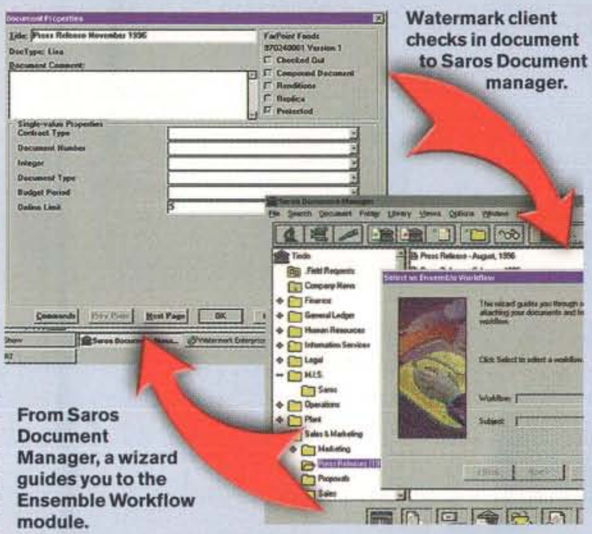
Datapro Report

Suites Solve Enterprise Info Management Needs

One of the biggest challenges facing global organizations is managing document-based information–often stored in disparate and incompatible systems. To eliminate these disparities, vendors have released application suites that integrate a variety of imaging and document management capabilities.

For example, FileNet (714-966 3400; http://www.filenet.com) recently announced the Saros Discovery Suite, a client/server solution that integrates imaging, management, and work-flow capabilities. Slated for general availability in the second quarter, the suite consists of Saros Document Manager, FileNet Ensemble for e-mail-based work flow, and Watermark Client for document imaging. The suite is a key component in FileNet's Foundation for Enterprise Document Management strategy. The Saros Discovery Suite ($495 per seat for 100 users) represents the culmination of FileNet's efforts to meld its own products with those of Saros and Watermark, which it acquired in 1995 and 1996. However, FileNet is not alone in delivering such a solution. The Enterprise Document Management System, from Documentum (510-463-6800; http://www.documentum.com), is a suite of client/server software products for enterprise-wide document management that includes built-in work-flow routing. Documentum EDMS accepts any type of object used in an organization (e.g., text, data, graphics, CAD renderings, engineering drawings, and multimedia files) and provides library services such as check-in and check-out, browsing, updating, searching, and viewing. It also provides version control, automatic format detection, annotation support, transformation and renditions, and query language for searching all objects.

Docs Open 3.5 Enterprise Suite, from PC Docs (617-273-3800; http://www.pcdocs.com), incorporates the Docs Open document manager with Docs Imaging and Docs Routing. Docs Imaging captures single- or multiple-page images for viewing on the Docs Open desktop. It is integrated within Docs Open's document management functionality. Docs Routing provides services for routing documents and folders to others for review, approval, and collaboration and does not require an underlying e-mail system. Docs Open Enterprise Suite costs $499 per client; server pricing starts at $3995.



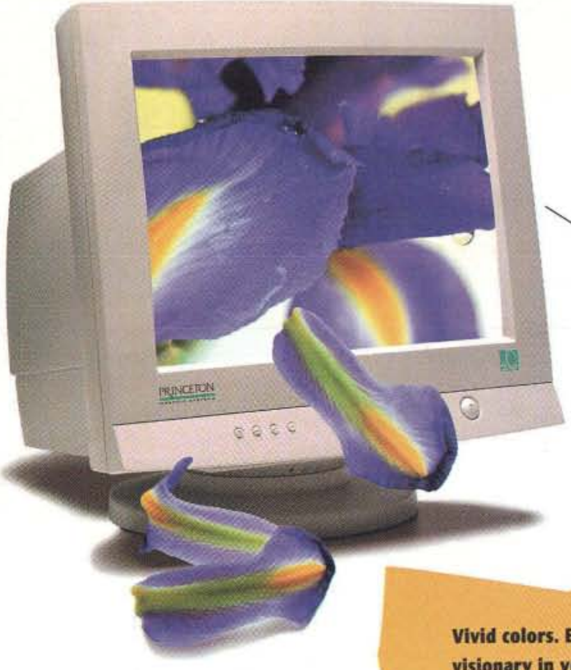
Watermark client checks in document to Saros Document manager.

From Saros Document Manager, a wizard guides you to the Ensemble Workflow module.

Lava, from Lava Systems (905-625-4000; http://www.lavasys.com), combines document management, imaging, and work flow into one package. Lava supports NT, NetWare, and most versions of Unix. Supported SQL engines include Oracle, Sybase, and others. Client software runs under Windows 3.1, 95, or NT. The $15,000 server software price includes licenses for 10 seats. With Lava's compound document management engine, users scan paper documents into Lava and integrate various objects such as e-mail, CAD drawings, digital video, and other types of files, including MS Office 95 file formats. Lava features include revision control, check-in and check-out, precedents, and templates.

Integrated document management suites represent a much-needed solution to the information management problems of global enterprises. One caveat: A major consideration for users and a primary differentiator among vendors will be the robustness of the individual components within the suite.

Karen Shegda, *senior analyst, Datapro Information Services Group. For more information on Datapro reports, call (609) 764-0100; fax (609) 764-2814; or visit http://www.datapro.com.*



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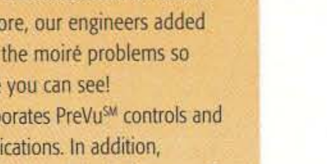

Case in point, the EO75. With its super-high 95KHz horizontal frequency, 200MHz video bandwidth and an ultra-fine 0.26mm dot pitch, this 17" (15.8" viewable) monitor delivers a bold, flicker-free resolution of 1600 x 1200 @ 75Hz. That's rock-solid performance. Furthermore, our engineers added Enhanced Imaging Circuitry for a sharper focus without the moiré problems so common to other 0.26mm monitors. That's a difference you can see!

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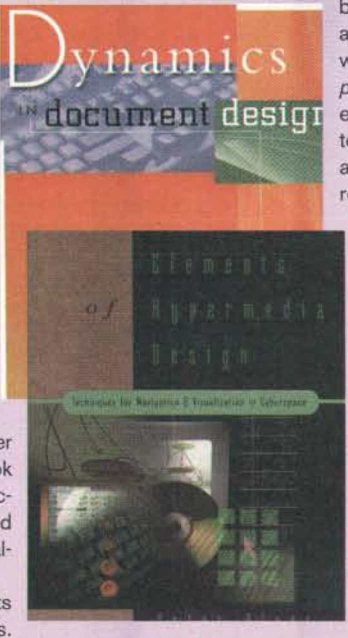
Book Reviews

High-Impact Design

Creating effective documents is part science and part art. If you lack a natural gift for the art, you can always master the science. And Karen Schriver's *Dynamics in Document Design* makes an excellent start. As should any good introduction, this book focuses on theory. Anyone looking for a step-by-step how-to guide will be disappointed.


Dynamics
in document design
Elements of Hypermedia Design
Techniques for Navigation & Visualization in Cyberspace

The concepts covered are media-independent. That is, you can apply them whether your work goes on paper, CD-ROM, or on-line. Schriver, an internationally known expert on document design, begins by making a compelling case for understanding design theory, followed by a history of the subject. Her accessible writing style and generous use of examples quickly draw you in. Her style actually made me look forward to reading the section on typography and space, which are potentially dull topics.

The book constantly puts you in the reader's shoes. You see how people react to poorly designed documents, how different elements entice readers, and how graphics aid in delivering the message. Perhaps the most important part of the book shows designers how to gauge and serve reader needs. A massive bibliography provides enough references to satisfy even the most curious design professional.

Dynamics in Document Design practices what it preaches. The book is impeccably designed, with lots of textual and graphic aids. A few cartoons provide welcome breaks.

Web site designers, documentation specialists, and user interface engineers stand to gain the most from Schriver's book. However, anyone who has to create business presentations or other kinds of documents for distribution will find *Dynamics in Document Design* valuable reading.

Schriver's book does have one glaring hole: It covers hypertext all too briefly. For professionals who work extensively in interactive media, *Elements of Hypermedia Design*, by Peter Gloor, is a worthwhile follow-up read. Like Schriver, Gloor focuses on theory, citing a number of important research projects. Where Schriver is lucid and entertaining, however, Gloor is dense and academic. In fact, the book appears to be aimed at a scholarly audience. For example, while *Elements of Hypermedia Design* covers a number of hypertext tools, most of them are used primarily for research and are not what commercial developers are likely to depend on. The author's focus here reflects his background. He is a former student and multimedia information systems researcher at the University of Zurich and MIT, and he is coauthor of the Gloor/Dynes Hypertext Engine (to which he devotes one chapter of the book).

Any additional effort multimedia professionals take to slog through *Elements of Hypermedia Design* is well rewarded, however. The core of the book covers what Gloor calls the Seven Design Concepts for Navigation in Cyberspace: linking, searching, sequentialization, hierarchy, similarity, mapping, and agents. Interactive media veterans might find this list obvious, but Gloor adds valuable perspective to these concepts with his own commentary and by citing findings of other researchers. He also makes good use of specific examples, such as the MIT Media Lab's ALIVE project.

Elements of Hypermedia Design is aimed at a narrow audience of multimedia researchers and toolbuilders. However, the book serves those readers well by providing a comprehensive state-of-the-art overview of hypermedia. **–Michael Nadeau**

Dynamics in Document Design, by Karen A. Schriver, Wiley Computer Publishing, ISBN 0-471-30636-3, $39.95, softcover

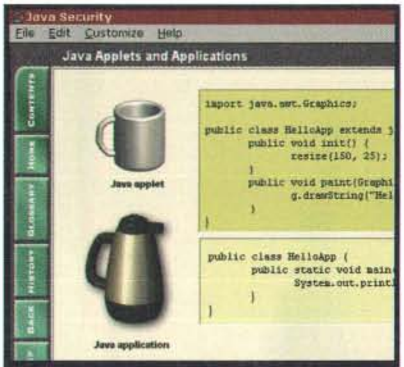
Elements of Hypermedia Design, by Peter Gloor, Birkhauser, ISBN 0-8176-3911-X, $46.95, softcover

Prevent Java Attacks

Good explanations but lame advice

Many organizations need Internet or Web connections, but they also want to protect their systems and data. Java's rapid rise as the cross-platform tool of choice, together with its transformation of what a URL can do, has compounded the problem.

This tutorial CD-ROM aims to explain to IS managers how Java security works and to suggest precautions. The authors explain the Java security model in understandable terms, including step-by-step details of (and fixes for) seven known attacks and weaknesses. Unfortunately, they offer much less in recommendations and virtually nothing that's Java-specific. Their bottom line: "The only way to completely eliminate the risks associated with Java is not to use it. This security measure is rather drastic since you also lose all of Java's benefits. However, if your information is critical, you can disable Java on all browsers or install a firewall that tries to stop Java applets." The authors suggest that users disable Java when visiting unknown sites. Yeah, right.



```
import java.awt.Graphics;

public class HelloApp extends J
        public void init() {
                resize(150, 25);
        }
        public void paint(Graphi
                g.drawString("Hel
        }
}
```

```
public class HelloApp {
        public static void main
                System.out.printl
        }
}
```

Java Security: Managing the Risks
By Gary McGraw and Ed Felton, MindQ Publishing,(800) MIND-008, (703) 708-9380, fax: (703) 708-9381, http://www.mindq.com/, ISBN: 1-57559-012-3, $59.95

If you want a clear explanation of Java security and its known flaws, this CD may be just the ticket. But many books on Java will give you more information for less money. **–Russell Kay**

Software Development West, San Francisco
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Better Data Delivery for the Net

Karen Milne, chair of the IP Multicast Initiative, talks about a solution to ease network congestion problems.

BYTE: *What is IP Multicast and how will it let applications make more efficient use of network bandwidth?*
Milne: To date, the vast majority of information sent to multiple recipients over the Internet or intranets has been unicast—the same information is sent repeatedly to every recipient. This impacts the performance of the server sending the data and quickly impacts available bandwidth in the network(s) between the sender and the receiver. Unicasting is basically unscalable. A T1 (1.5-Mbps) connection, for example, is filled up by only 55 fully utilized 28.8-Kbps data streams! IP Multicast is an IETF [Internet Engineering Task Force] standards-based solution to this problem. Steve Deering is the inventor of IP Multicast. He wrote RFC1112, which basically defines extensions to IP that enable one stream of data to be received by multiple recipients. Only one copy of data destined for multiple recipients travels across the network(s) between the sender and the receiver.

To take advantage of IP Multicast, applications use very straightforward extensions to the BSD 4.3 Berkeley Sockets API. These are supported on most major OS platforms including Unix and Microsoft Windows 3.1, NT, and 95. Applications that want to receive multicast data do so by joining a host group. The group itself is identified by a special Internet address known as a Class D address. This is roughly analogous to a TV channel or radio station. A key component of IP Multicast is IGMP, the Internet Group Management Protocol, which enables hosts to report their membership in a particular group to a multicast-enabled router. These routers handle the delivery efficiently.

BYTE: *Besides video over the Internet or intranet, what other applications will take advantage of IP Multicast?*
Milne: Audio and video streaming are certainly mentioned a lot and need IP Multicast to scale to thousands, tens of thousands, and even larger numbers of recipients. But numerous other applications can substantially increase their performance, efficiency, and scalability by using IP Multicast. Analysts consider software distribution to be one of the biggest growing opportunities. That means pushing a lot of data over already crowded networks. We're starting to see an increasing number of enterprises examine and deploy IP Multicast across private satellite networks for simultaneous software or data distribution.

Clearly Internet "push" technologies are becoming increasingly fashionable. Their mode of operation is based on a publish-and-subscribe model. These products will absolutely have to take advantage of IP Multicast to achieve appropriate throughput and end-user delay thresholds, especially as the data they contain becomes richer with animation, audio, and video. Another key feature of IP Multicast is the almost simultaneous delivery of information, which is valuable to various user communities, including financial traders. Web caching and mirroring, database replication, and groupware can benefit from IP Multicast, too.

For more information on IP Multicast-enabled products and services, see **http://www.ipmulticast.com**.

Blasts from the Past

5 Years ago in BYTE

PDAs and pen computing technologies were in the news, and Apple CEO John Sculley promised that Apple would enter the "digital consumer information electronics industry." The recent release of Windows CE and the latest MessagePad prove that companies still think that market can be big. Meanwhile, we also previewed Windows 3.1.

10 Years ago in BYTE

We previewed Apple's Mac II in the same issue that we discussed the future of RISC chips. We also looked at OCR machines that you used with your PC to convert printed documents into machine-readable text. The devices were an improvement over earlier models, but some choked on graphical logos and underlined text.

15 Years ago in BYTE

We were wowed by the IXO Telecomputing System, a PDA precursor that cost about $500 and let you access on-line services.

We also took an in-depth look at the influential Star, which offered, among other things, a WYSIWYG, bit-mapped, graphical display.

20 Years ago in BYTE

Articles included a primer on artificial intelligence and a tutorial on a faster (1200-bps!) audiotape interface.

BYTE EXTRA

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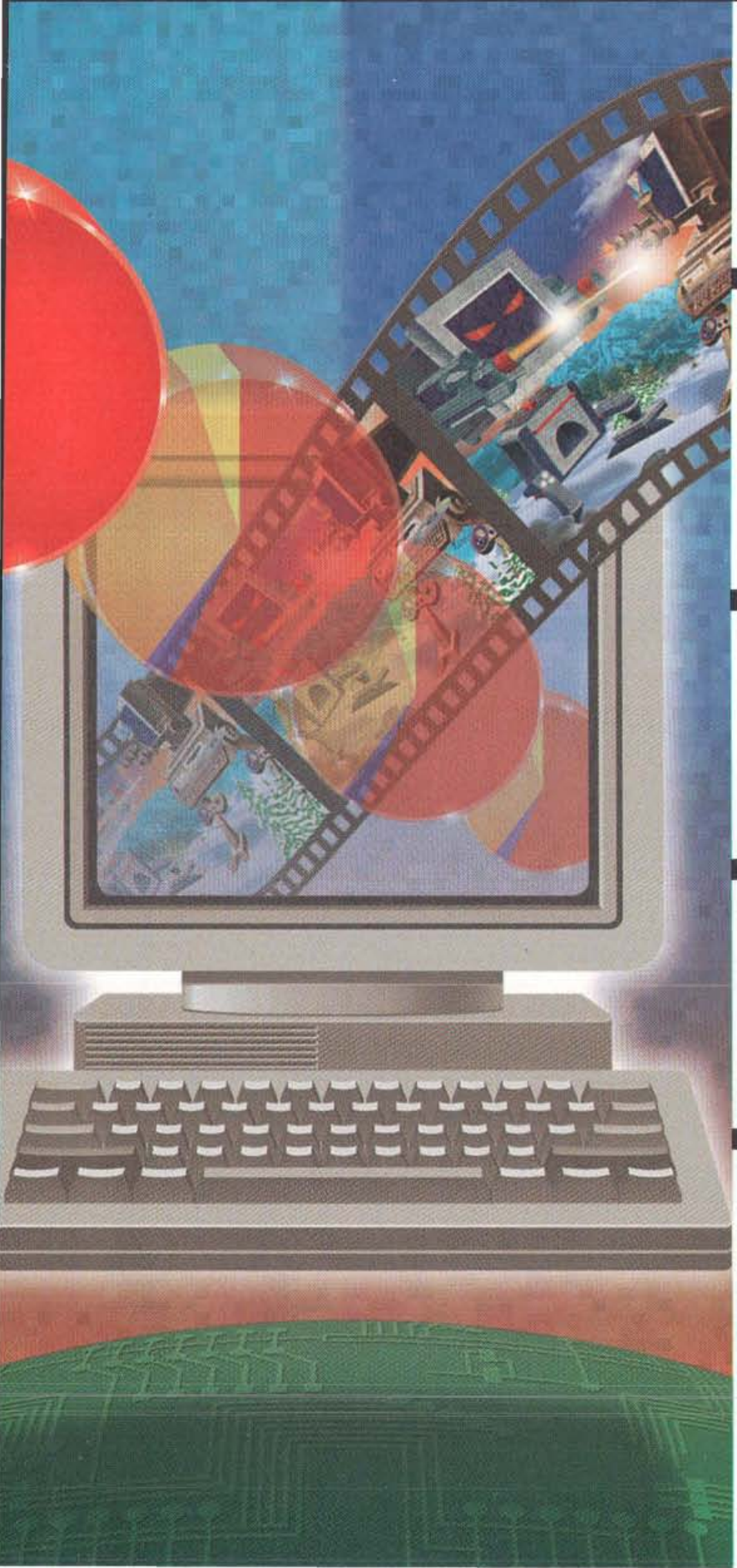


A Wider Choice of CPUs

More competition for Intel.
Page 40IS 3

Capture 3-D Images

New hand-held 3-D scanner simplifies a complex task.
Page 40IS 3

Smartcard Stampede

Smartcard applications proliferate.
Page 40IS 7

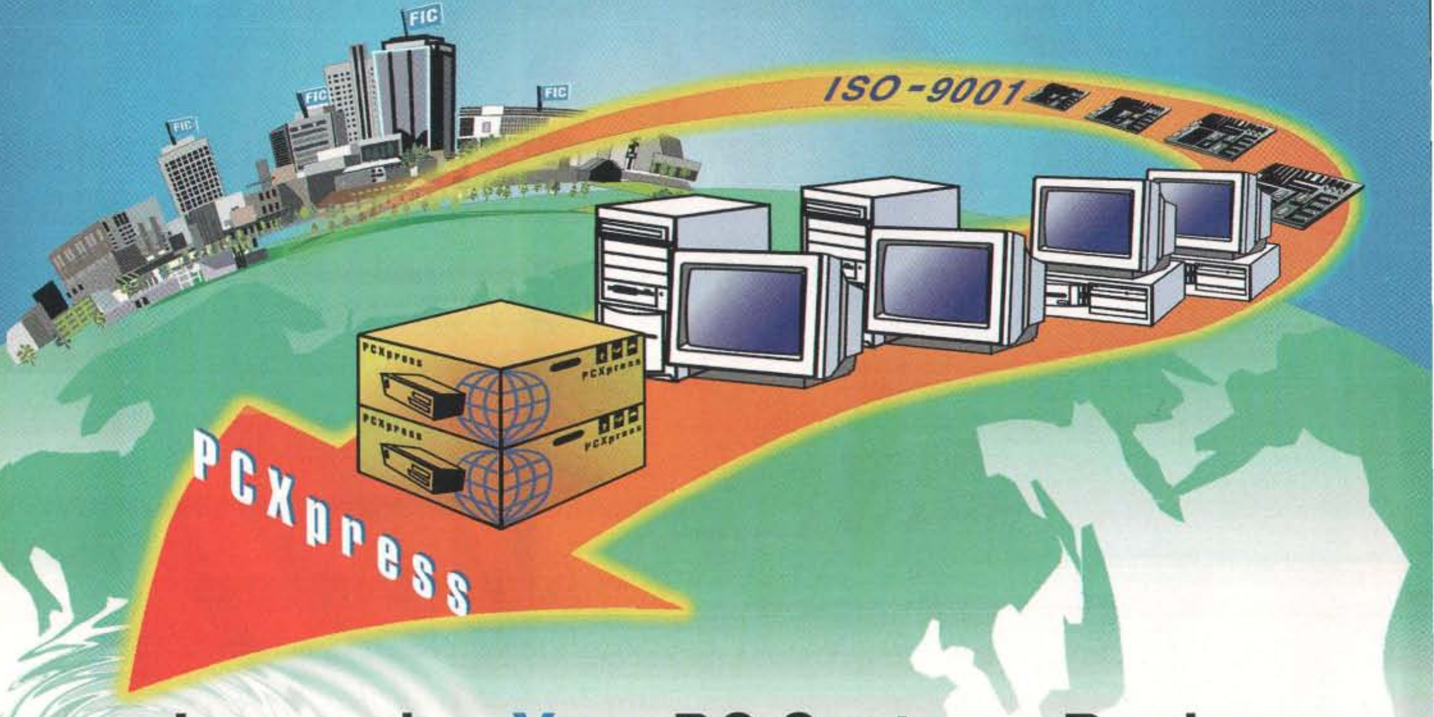
Build Better Software

Tools that help raise quality.
Page 40IS 15

Marvelous Multimedia

3-D graphics and full-motion video in a $1200 PC. *Page 40IS 25*

The Fast Track To..



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Finally—A Choice of CPUs

New PowerPC speed demons and Klamath competitors from AMD and Cyrix.

Unlike last year, when Intel had the PC-processor market mostly to itself, consumers this year have a choice of CPUs. Whether they will take advantage of the new competition though remains to be seen.

Intel's offerings are the benchmark by which to judge the market. Its P55C on the Pentium level and Klamath on the P6 level will be the best-selling CPUs this year. This won't necessarily be because of pricing or performance considerations. Rather, it's a result of the company's "Intel inside" marketing and the fact that it's the largest OEM mainboard manufacturer in the world. For the record, though, the P55C delivers two instructions per clock cycle at 200 MHz with no speculative execution. Klamath offers three instructions per clock cycle at 266 MHz with speculative execution. Both are 32-bit CPUs with 2×8 registers, 2×16 on-chip caches, 64-bit memory, and secondary cache buses.

Challenging Intel in terms of price and performance are this year's offerings from Cyrix and AMD. Both chips offer performance almost at the level of Klamath at a price similar to the P55C or about 30 percent less than Klamath. Like Intel's offerings, Cyrix's M2 and AMD's K6 are 32-bit CPUs with 2×8 registers, 64-bit memory, and secondary cache buses. Both chips have speculative execution. The M2 processes two instructions per clock cycle, but the K6 offers four. Clock speeds are 225 MHz for both. The on-chip caches for both chips are superior to Intel's at 2×32.

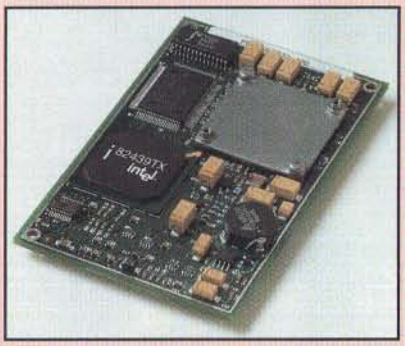
RISC processors offered by IBM/Motorola, Exponential Technology, and Digital Microelectronics handily trounce Intel CPUs in performance and clock speed. PowerPC 603e and 604e processors available from IBM and Motorola start at about 250 MHz and are now reaching 300 MHz. Exponential's X704, a PowerPC-licensed design, races along at speeds of 466, 500, and 533 MHz. Additionally, IBM and Motorola have announced the first in a series of next-generation PowerPC processors, code-named G3. The first G3 will be targeted at mobile and high-performance desktop systems. It uses the 604e's dynamic branch prediction to boost its performance, and one version of the processor provides direct L2-cache support for high-end designs. At 250 MHz, the G3 consumes only 5 W of power, making it suitable for notebooks. One version of the G3 is pin-compatible with the 604e.

Expect to see G3-based systems about midyear. Because the G3 has little multiprocessor support, the 604e will still handle multiprocessor systems, while the 603e will be found in low-cost systems. However, the 603e is available at brisk 240-MHz speeds and is expected to reach 300 MHz this year—not bad for a low-end processor. Despite the higher clock speeds, the PowerPC and G3 processors are relatively inexpensive to manufacture, which translates into cost savings for systems designers. The Exponential X704's high speed comes from a hybrid bipolar and CMOS process with higher manufacturing costs. Exponential will also charge a premium for those demanding the X704's ultra high-end performance: about US$1000 in large-volume orders of the 533-MHz chip.

continued

Intel's New Laptop Upgrade Board

Because laptops/notebooks are so small physically, anytime you change one thing, it tends to ripple throughout the system and you generally have to redesign everything. For example, a new processor that puts out a bit more heat may require changes to the power supply, the heat-control systems, and physical placement on the motherboard with respect to other heat-producing components. Also, each new CPU generation has called for a complete redesign. Each time, the laptop maker has to reengineer many systems and circuit timings and expend significant resources on things that, in the end, don't add any more value to the product but just make it work.



Intel's new plug-in module contains all processor-specific circuitry.

Intel has a new answer to this problem. Its plug-in daughterboard incorporates all processor-specific circuitry and support functions: CPU, L2 cache, memory manager, system clock, and PCI chip set. The first modules will be 150-MHz Pentiums, with 166-MHz versions to follow soon. Besides the CPU, the board (official name: Intel Pentium Processor with MMX Technology Mobile Module) contains the new 430TX PCI support chip set. The idea is that the laptop maker/designer can upgrade by simply replacing the Mobile Module with the next version and will not have to make any other changes. **–Russell Kay**

Digital Microelectronics' CPUs are the performance and price top of the line. Thanks to Microsoft, these chips are compatible with Windows NT and its applications, making them a definite choice in the server market. Currently, the company offers the Alpha 21164, which processes data in 64-bit packages and four instructions per clock cycle. It has a 500-MHz clock speed. Registers are 2×32, and both secondary cache and memory buses are 128 bits. In the fourth quarter, Digital Microelectronics will offer the 21264, taking CPU performance to new levels. This chip is planned to offer similar specs as the 21164, but with speculative execution at six instructions per clock cycle with a clock speed of 600 MHz. Intel will remain on top this year in terms of volume, but at least consumers now have a choice.

–Mark Carroll and Tom Thompson

A Better Grasp of Reality

In contrast to 2-D images, capturing 3-D content by digitizing an existing object has been a complex, skilled, and costly activity. A new hand-held 3-D scanning system called ModelMaker, developed by 3D Scanner (London, U.K.), drastically simplifies the procedure. "It's as easy as taking a photograph," says Peter Champ, a product manager with 3D Scanner.

ModelMaker measures 3-D data using a principle known as laser triangulation. A beam of laser light is projected as a stripe onto a 3-D object and scanned by a videocamera. A dedicated 3-D image-processing board in a PC captures the contour in real time and displays it immediately on the monitor. To continuously update the spatial coordinates of the system, the laser sensor sits on a flexible-position sensing arm and can be moved over the surface of the object. Software running on the PC produces a color 3-D image accurate to 0.3 mm. ModelMaker's price starts at around £21,000, but hand-held 3-D scanners are expected to have a strong impact on industrial applications.

–Rainer Mauth

With a hand-held 3-D scanner, you can capture spatial models more efficiently.

CeBIT Software Highlights

New software applications were an important part of this year's CeBIT.

Xbase++ for Windows 95 and Windows NT: Alaska Software's multiplatform development environment Xbase++ is a Clipper 5.2x–compatible native-code compiler that lets you port existing DOS applications to more advanced OSes such as OS/2, Windows 95, and Windows NT without changing the source code. It supports legacy code as well as XbaseParts GUI components. Xbase++'s database engines strictly separate the development language and the underlying database providing native DBF/NTX/CDX and SQL database access.

F-Secure Internet security: While the Internet community wrestles with implementing robust encryption and key management standards, Finnish software developer Data Fellows introduced a suite of Internet security products that capitalize on the Secure Shell (SSH) protocol. F-SecureVPN lets corporations create a secure, encrypted Virtual Private Network (VPN) over the Internet. F-Secure Commerce extends the Secure Electronic Transaction (SET) protocol by encrypting the transaction's order information, which SET doesn't protect. In addition, F-Secure Desktop for Windows 95 secures data on standalone machines. Its AutoSecure automatically encrypts predefined sets of files, directories, and folders every time you start or close Windows.

F-Secure Commerce

Security with Strong Encryption

F-Secure Commerce can be used to create an authenticated and encrypted tunnel using the SSH protocol between any SOCKS capable World Wide Web browser and any server product. The encryption methods include DES, 3DES, IDEA, Blowfish and RSA with key lengths up to 256 bits for symmetric algorithms and 1024 bits or more for RSA. The solution can be automatically deployed in any organization and can be made totally transparent from the end user's point of view.

Get the pricing information for the F-Secure Product Family.

F-Secure Commerce provides additional security for Internet transactions.

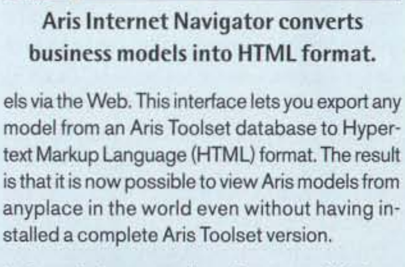
Unix and Windows NT development tool: TakeFive's Sniff+ provides the same development environment under Unix and Windows NT. It facilitates cooperation in multiplatform development teams. The tool also supports a variety of compilers, debuggers, and editors for C, C++, Java, FORTRAN, and interface definition language (IDL).

Encryption for X.25 and frame relay: Business Security introduced a series of WAN encryption engines. This WAN security solution carries out encryption on individual logical channels with different encryption keys.

Stardivision announces StarOffice 4.0: With the latest version of this cross-platform office suite, you deal with one type of document, no matter if you create a spreadsheet, a presentation, or an e-mail message. It features context-sensitive menu bars that automatically adjust to the task (e.g., working on a diagram or formatting an e-mail message) you are performing.

Jukebox network file server: iXOS-Jukeman 2.1, a CD jukebox network file server, now supports a wide range of OSes, including the Unix flavors from Sun Microsystems, IBM, Silicon Graphics, Hewlett-Packard, and Digital Equipment, as well as Windows NT for Alpha and Intel processors and the Mac OS. A newly integrated "device browser" recognizes and configures the jukeboxes automatically.

Business modeling over the Internet: IDS-Professor Scheer's Aris Internet Navigator 1.0 provides access to Aris business process models via the Web. This interface lets you export any model from an Aris Toolset database to Hypertext Markup Language (HTML) format. The result is that it is now possible to view Aris models from anyplace in the world even without having installed a complete Aris Toolset version.



Aris Internet Navigator converts business models into HTML format.

Integrated messaging: Fenestrae's Faxination 3.0, a Windows NT–based communications gateway, lets users of Microsoft Exchange and SAP R/3 send and receive faxes, telexes, and Global System for Mobile Communications (GSM) phone or pager messages directly from their desktop. It also converts all Office 97 and ActiveX documents on the fly and supports encrypted fax lines.

–R. M.

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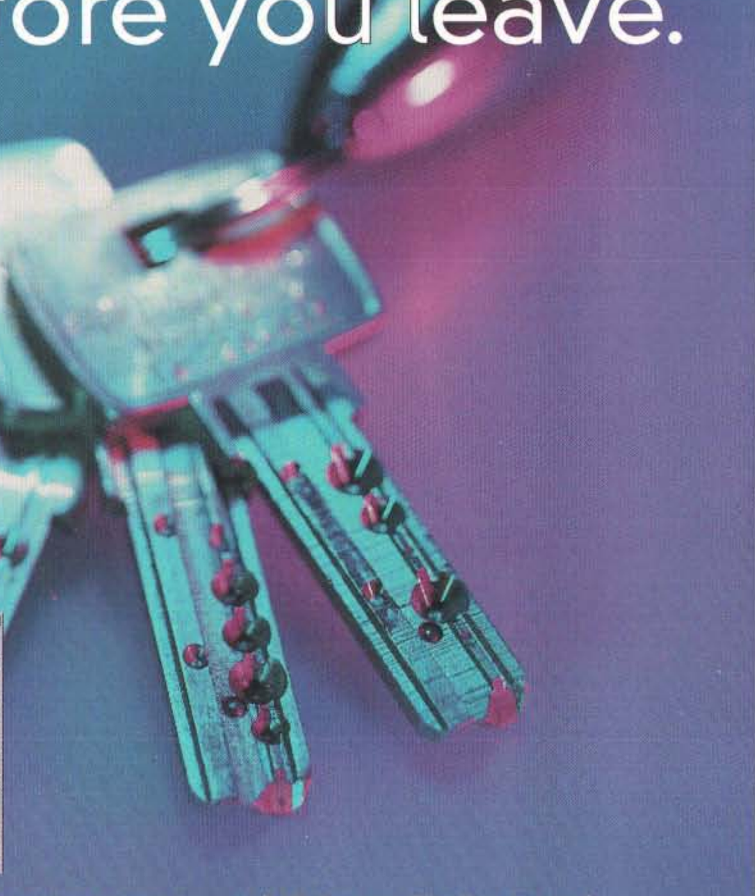

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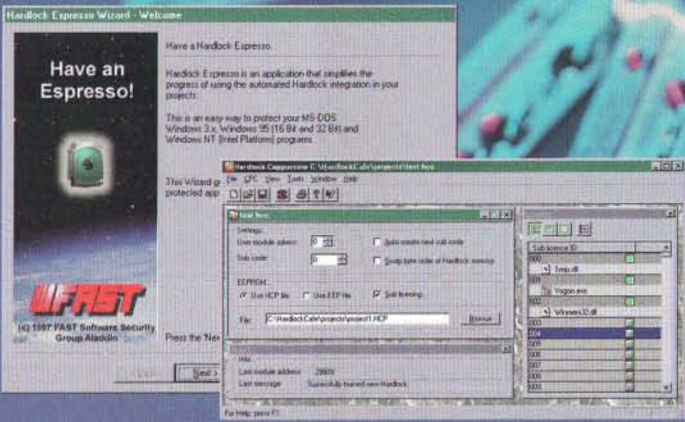

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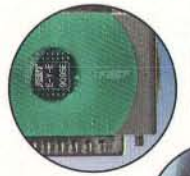

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News & Views

VISUAL BASIC 5.0

At Last, VB Gets a Compiler!

Visual Basic 5.0 is finally due to be launched on March 19th. We have no firm details yet, but it is expected to include the following:

- **Developer Studio IDE** with "smart" editor, SDI or MDI, new forms engine, lots more
- **Native Code Compiler** (not in Standard) or p-code.
- **Create ActiveX Controls** and put them on your Office 97 toolbars
- **Function Addresses** allow callbacks (hurray!)
- **Rational Object Modeler** supports business process, data, object & application modeling, generates source code
- **Enterprise Edition** includes a repository (with API), advanced network OLE functions and database enhancements (high-speed local cursors, batch updates, cursor update events, asynchronous options, etc, etc)

Plus much, much more, as they say! Call us for full details and pricing, including updates.

VISUAL C++ 5.0

More Client/Server & Web Support

Visual C++ 5.0 is also due on March 19th - expected new features include:

- **ActiveX Template Library** (ATL)
- **Thin-Client** rapid development with MFC
- **Three-Tier** apps with COM and the new Transaction Server

Call us for full details on this exciting new release.

VISUAL J++ 1.1

Create COM objects

Visual J++ 1.1 is also due on March 19th - it will let you create COM objects and integrate them into a Web server for use by any browser.

Call for more details and update pricing.

ASYMETRIX SUPERCEDE

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Asymetrix's new Java RAD tool has some really outstanding features that make it well worth checking out:

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There is no space to do justice to SuperCede - any Java developer should call us for full details. No pricing as we went to press - but it should be competitive.

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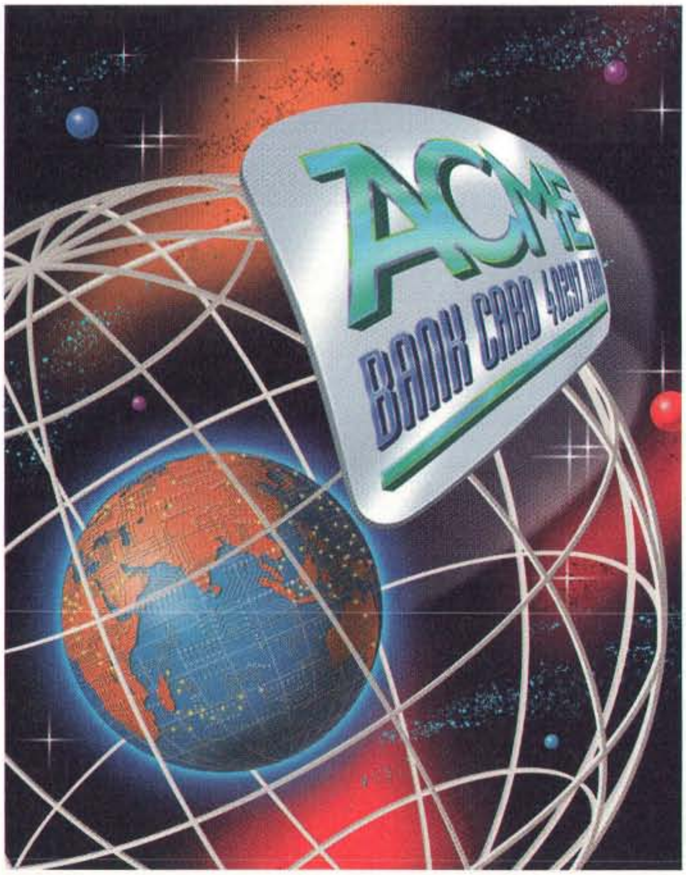
European Banks Play Their (Smart) Cards

Banks turn to smartcards to provide security and new services for on-line transactions.

By Dan Amdur

Tucked in a warehouse outside of Marseilles, France, lies a vision of the future: a "smart village" where fees for parking meters, public transportation, movie tickets, and pay phone calls are digitally debited through chip cards. In other parts of this mock virtual city, smartcards act as the keys that unscramble a set-top box and unlock a corporate computer, while a medical smartcard records a patient's blood-pressure information from a home test for a doctor to scan during that patient's next office visit.

This smart city is actually a demonstration created by industry leader Gemplus two years ago to highlight the potential uses for smartcards. However, for banks in France and across Europe, this exhibit represents the finish line in the current race to offer the next generation of services to consumers and corporations alike in an increasingly wired world. While the Internet remains a top priority, many hopes are being placed on smartcards' ability to move Europe's financial system beyond that of the rest of the world—especially with the prospect of a unified currency becoming more likely with each passing month.



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Setting Standards

Since exploding on the scene in the U.S. three years ago, the Internet has largely remained an American institution. Although dozens of banks throughout Europe have also jumped on-line, most home-banking standards are being set within the U.S. by companies such as Intuit, MasterCard International, Microsoft, and Visa International. But while the near-term on-line future is being blazed in the U.S., banks and merchants in Europe are quietly pioneering the infrastructure for a secure transaction environment based on chip cards that bridge the gap between retail and virtual sales.

According to the market-research firm Dataquest (San Jose, CA), 90 percent of worldwide integrated-chip-card shipments went to Europe in 1995, while only 2 percent headed to the Americas. By the year 2001, Europe is expected to account for only 40 percent of these shipments, while Asia will command 25 percent and the Americas 20 percent.

Considering the lack of market penetration in the U.S. today, these figures can be interpreted as positive growth. But the reality of smartcard deployment in the Western Hemisphere is that many South American countries will be much more rapid adopters than the cautious banks of the U.S.

U.S. Lags Behind

A number of U.S. banks have thrown their support behind the electronic-purse systems pushed by MasterCard International and Visa International within the past year; the 1996 summer Olympics was heralded as the first step down the road to widespread consumer rollouts. However, squabbles over card formats, poor merchant outreach, and delayed commercial trials are all hampering the introduction of smartcards in North America. This situation is giving Europe the chance to command the lead in the growing market for card-based services.

"The U.S. market as we know it is not quite ready for smartcards," says Paul Campbell, spokesperson for Schlumberger Industries' Electronic Transactions Division. "We're all waiting for the U.S. market, but the market most likely to develop first by the year 2002 is the European one," agrees French journalist Charles Copin, a longtime follower of the smartcard industry.

continued

Although countries such as Belgium and the U.K. are currently experimenting with chip cards, the country with the widest penetration of cards in both its financial and social structure is France. This is where the first true chip card was developed in 1967 and where many of the major players in the chip-card industry originate. One of the core reasons that chip cards were adopted at such a steady pace in France was the pivotal role the government played in mandating their use.

In this environment, achieving significant penetration of chip cards was much simpler for banks, which pushed for chips to be installed on credit and debit cards. Now there are more than 25 million chip bank cards in France, with 85 percent of card payments made using a personal identification number (PIN) for security.

Smartcard Market Forecast

Segment	1995 (millions of units)	2000 (millions of units)	Average yearly growth
Phone cards	370	1400	30%
GSM	20	120*	43%
Health	17	400*	88%
Bank and loyalty	30	500*	76%
Identification	2	300*	163%
Transportation	5	400*	140%
Pay TV	10	120*	58%
Gaming	1	300	228%
Metering	5	60	58%
Access control/vending	5	200	109%
Total	**465**	**3800**	**52%**

* Microprocessor cards

Source: Gemplus

High Start-Up Costs

For European banks, there are multiple benefits spurring the move toward smartcards. For example, the proliferation of electronic-purse schemes is creating a new source of revenue for banks, which are facing growing competition from outside firms that offer a wealth of new financial services, from investing to banking.

Under many of the stored-value card systems now under evaluation, digital currency resides in an account-holder's bank, as opposed to residing on the card itself. In turn, banks stand to profit from the "float" that exists while consumers leave their digital cash idle on their cards. In France, for instance, about 3 percent of the value of prepaid phone cards is never used. This could translate to large unused sums of money in an electronic-purse system.

Alternative European Security Systems

Credit-card institutions, such as MasterCard and Visa, are now jumping on the Internet bandwagon, establishing what they hope will become the worldwide standard for securing payment-card transactions over open networks. The Secure Electronic Transaction (SET) specification, developed by MasterCard and Visa in cooperation with major industry players, including IBM, Microsoft, and Netscape, is a Rivest-Shamir-Adleman (RSA)–based transaction scheme. It lets customers use private keys to encode their identity and allows banks to use a public key to decode customer signatures, verifying the authenticity of their requests.

But "most Europeans feel that they should not be depending on an American security system alone," says Kurt Schoenmaekers, managing director of Utimaco Safeware, a developer of information-security products. He adds that because of strict U.S. export laws, even non-U.S. companies depend on the approval of the U.S. government.

As a result, European banks and financial institutions are working on their own Internet banking schemes. The Home Banking Computer Interface (HBCI), for example, was developed by a consortium of German savings banks, including the Sparkassen Informatik Zentrum (SIZ) and the Zentraler Kredit Ausschuss (ZKA), to meet the requirements of the German banking sector. Like SET, it deploys RSA for message verification and encryption.

In a typical HBCI transaction, a password authorizes a user to access the banking system. Each user has a unique electronic signature based on an RSA algorithm. Unlike a symmetric algorithm, such as DES, an asymmetric algorithm like RSA works with both a private key and a public key. The private key remains secure on the user's home-based PC. The bank uses the public key to authenticate the user and validate his or her signature.

The HBCI architecture also includes a mechanism to check for message integrity by placing a signed hash code over a message. A hash code is a cryptographic checksum that is unique to each transaction but allows for the identification of users and messages. The receiving bank's Web server then checks the message's integrity by recalculating the hash code. If a message is altered during transmission, the hash code reflects that alteration, and the transaction request is invalidated.

HBCI also ensures that if a message transmission is intercepted for some reason, it will not be accepted if it's resent later. In addition, HBCI supports smartcards with encryption coprocessors. "Smartcard-based on-line banking is more secure and, especially in the mass market, easier to handle for banks," explains Hans-Peter Dünnwald, HBCI project manager at SIZ.

–Peter Hofland and Jim Utsler

For merchants, however, the benefits of adopting a new payment type at the point of sale are less clear—especially in the current climate, where as many as four different standards (CLIP, Mondex, Proton, and VisaCash) are competing in the electronic-purse market and boosting the cost of terminals. High costs are also forcing banks to take a cautious look at the business benefit of issuing chip cards that cost between $2 and $8 each, depending on the application, versus magnetic-stripe cards, which can be produced for just 10 cents each.

In addition, banks are reluctant to commit to new technology and new payment types before consumers are prepared to embrace them. Jean-Pierre Camelot, director of Groupement des Cartes Bancaires, the French bank association that's charged with exploring new technologies, estimates that it will cost French banks as much as $1 billion to introduce a widespread electronic-purse method in that country. This figure could skyrocket for rollouts in other European countries.

Other Competition

A key driving force behind chip-card use for bank cards in Europe is the idea of enabling off-line transactions by the use of PINs to reduce the fraud rate. With telecommunications costs at a premium in

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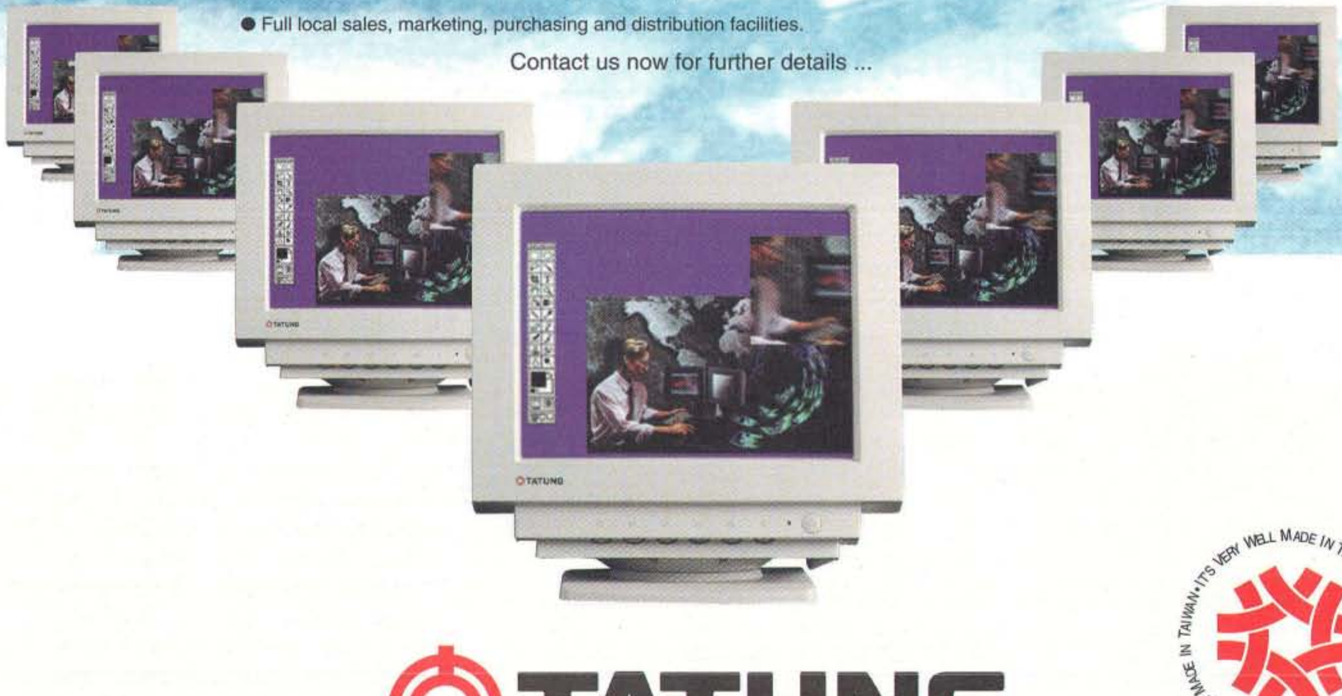

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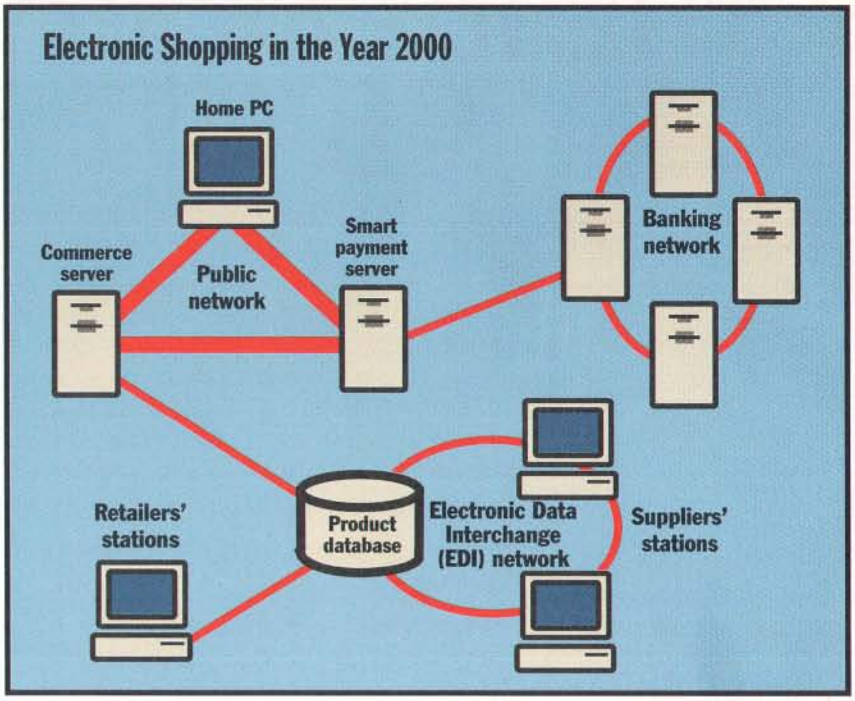
Circle 735 on Inquiry Card (RESELLERS: 736.

many regions of Europe, merchants have a strong incentive to move toward a chip-based approach that can support off-line transactions.

In addition to the reduction of fraud, two other main drivers for spurring smartcard adoption are the emergence of Internet commerce and the aforementioned possible competition from nonbank entities. "Smartcards are a key element of the future of information technology," affirms Tim Baker, head of technical communications for Gemplus.

Currently, the Secure Electronic Transaction (SET) specification is being rolled out by MasterCard and Visa to safeguard credit-card purchases conducted on the Web. SET is based on the use of a digital certificate residing on a user's hard drive. Visa and MasterCard, along with Europay International, are adapting the specification so that it operates with a smartcard, rather than a PC, as the secure token that holds the digital keys.



Twelve companies are participating in the Eureka project, which aims to produce a secure electronic-shopping service by the year 2000.

Bringing smartcards into the Internet market can improve security for transactions while also giving consumers portability, since they won't be tied to their PCs to use them, says Michel Roux, general manager of the Gemplus Multimedia Business Division. This portability comes in handy when working with access-control applications on intranets and other corporate networks, another very big potential market for the cards, he adds.

Gemplus is currently working with Visa to launch a pilot this year that combines SET with smartcards. In addition, a variety of terminal vendors, including Dassault Automatismes et Telecommunications and VeriFone, are developing inexpensive plug-in smartcard readers for PCs. Also, modem manufacturer Hayes has announced that it's building smartcard support into its line of modems.

While the virtual world represents a promising market for chip cards, more immediate room for expansion comes from applications promoted by nonbank industries. This has forced banks across Europe into partnerships to prevent cards issued in loyalty programs from shutting out traditional financial institutions.

One such focus of competition in France runs up and down the railway lines that crisscross the country. Cards are already becoming a popular tool for aiding the transportation industry through contactless initiatives, such as the Tunnel Prado-Carenage in Marseilles, where one-quarter of the 30,000 cars that now travel through the tunnel each day pay their tolls with wireless smartcards.

But in the next few years, local and national transportation authorities alike will be heavily promoting smartcard use

Stronger Netscape Encryption

Brokat (Böblingen, Germany) addresses server security with its so-called Integration Platform. This scheme applies proxy technology that allows users to access mirror images of a bank's database without accessing the database itself.

Brokat recently joined forces with Netscape to incorporate Java into its security products targeted at the banking industry. Using cryptography applets, Brokat's XsPresso Security Package adds 128-bit encryption to Netscape Navigator's 40-bit keys, which U.S. export laws prescribe. German banks Bank 24 (http://www.bank24.de), Advance Bank (http://www.advance-bank.de), and Direkt Anlage Bank (http://www.diraba.de) have all decided to implement this Brokat/Netscape transaction-security solution.

Meanwhile, G&H Bankensoftware (Berlin, Germany) has developed a similar approach, called Bancos Online. This Internet home-banking package includes a multilevel security architecture. In addition to using the encryption of Netscape's Secure Sockets Layer (SSL) protocol, Bancos Online transfers data between the customer and the bank according to a Java-based 128-bit algorithm. This higher level of security is possible because the encryption system was developed in Europe, therefore not conflicting with strict U.S. export regulations.

The Bancos Java applet uses three security schemes. It performs Rivest-Shamir-Adleman (RSA) public- and private-key encryption; uses a 128-bit International Data Encryption Algorithm (IDEA), developed by Ascom Systec (Mägenwill, Switzerland) and the Swiss Federal Institute of Technology (Zürich); and employs the Message Authentication Code (MAC), which checks for message integrity.

Both the Brokat Integration Platform and the Bancos Online system require users to enter personal identification numbers (PINs) and other personal identifiers to obtain access to their account information. Without them, any access to other than the most public Internet interface is disallowed. "With just your PIN or password, you might be able to check on the latest interest rates, but you're not allowed to download currency or transfer funds," a German on-line banking expert explains.

–Peter Hofland and Jim Utsler

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Circle 714 on Inquiry Card.

for ticketing and retail applications. Groupement des Cartes Bancaires recently announced it was forming a working group to manage an electronic-purse project for transport and shopping services. The move was largely a defensive one, since the national French railway organization, Societe Nationale des Chemins de Fer Francais (SNCF), has been pursuing smartcards for ticketing applications for years. But instead of directly competing against SNCF, French banks are grudgingly agreeing to develop interoperable specifications that can be used for both transportation and retail applications.

Merchant Support Is Critical

"All present electronic-purse pilots have proved unsuccessful because they have not had enough merchant support," says SNCF treasurer Eugene Caffart. "We provide a critical mass of users, and we expect these users to pressure shops to accept these cards later."

The merging of transportation and retail applications presages an effort under way in France to create a universal electronic purse that incorporates other payment applications, such as public phones. Phone cards, bank/loyalty cards, and transportation cards will represent the three largest chip-card markets by 2000, according to internal estimates from Gemplus and Schlumberger. Merchants are already turning a wary eye toward these types of closed systems in anticipation of a wider potential market.

One early outside merchant to take an interest in the SNCF project was fast-food giant McDonald's, which became a member of the working group in 1991. Still, the prospects for a universal card and nonbank competition remain slight in several European countries, despite rollout promises in the U.K. and Germany.

MeChip Gives Added Security

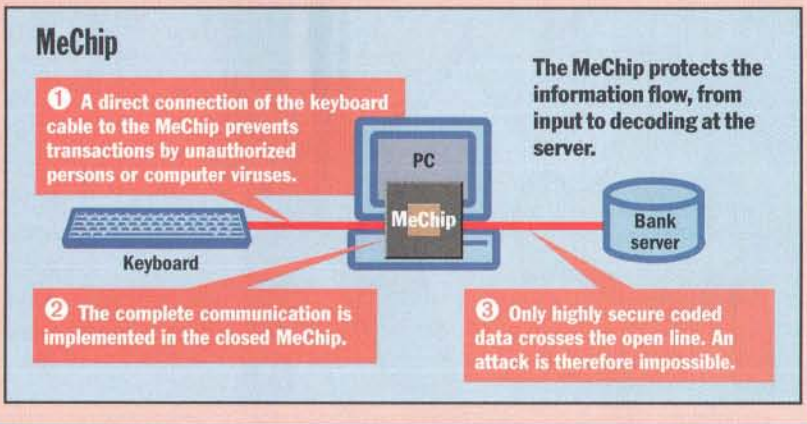
An open network like the Internet has many security threats, such as Trojan-horse-type viruses that invade users' desktops and tamper with transactions before they can be encrypted. Germany's Sparda Bank (http://www.spard-hh.de) addresses this type of client-end security issue by using a special encryption chip that plugs into a PC's parallel port and keyboard and encrypts all information on-board before any software can access it. Each one of these so-called MeChips, from ESD Software (Leipzig, Germany), is serialized, and thus unique to each banking customer.

To avoid infection by viruses, each chip has a direct connection to the client PC's keyboard, bypassing the PC's processor. Thus, all information related to the banking transaction passes through the MeChip, where it gets encrypted and authorized and then forwarded to the bank. All data transmissions are logged and verified when the bank receives them. If any deviations are found in a transaction, it's terminated immediately.

According to ESD, the only weak link in this security chain is the user, who is responsible for keeping his or her personal identification number (PIN) secret. The MeChip also supports smartcards, so customers are able to reload their electronic purses just as they would load their wallets after visiting an ATM.

Of course, it's not just the client side of these transactions that's vulnerable to hacker attacks. Sparda Bank, in cooperation with Siemens Nixdorf, has therefore developed a multilayered shell of servers to protect banks' host databases. The first server in this Sparda Bank security scheme is the MeChip server, which is backed up by a series of additional servers.

In addition, Sparda Bank encrypts financial data for processing within its internal account-management and transaction system, creating a layer of protection against internal tampering. Both an external wall of multilayered servers and an internal padding of data coding prohibit potential thieves—both outside and inside the walls of Sparda Bank—from accessing sensitive financial information. **—Peter Hofland and Jim Utsler**



MeChip

The MeChip protects the information flow, from input to decoding at the server.

❶ A direct connection of the keyboard cable to the MeChip prevents transactions by unauthorized persons or computer viruses.

❷ The complete communication is implemented in the closed MeChip.

❸ Only highly secure coded data crosses the open line. An attack is therefore impossible.

To be successful, banks across Europe will need to wring more revenues out of chip-based stored-value applications than they do in the lower-cost debit environment, according to reports from Retail Banking Research. With merchant investments already extensive in their support of existing debit terminals, banks will need to help finance merchant migration toward this new payment standard over the next few years, the research firm adds. This will be a necessary step toward promoting consumer use, since many consumers are unlikely to adopt these new stored-value applications unless they are guaranteed widespread acceptance for low-value retail transactions, ranging from fast food to gas stations. **B**

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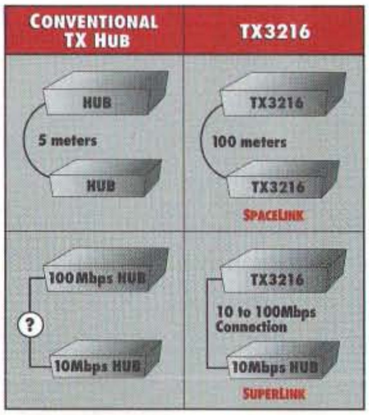

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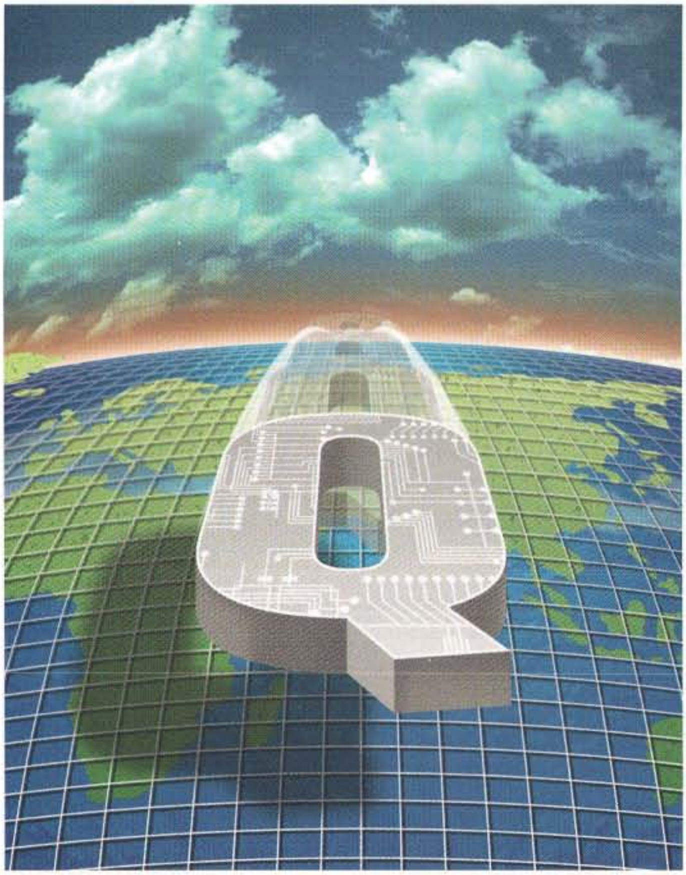
The Quality Factor

How do you ensure better software quality?
An ISO-9000-compliant scheme is one way to go.

By Bruce Tober

In today's highly competitive international software market, software developers are increasingly asking: "How can we produce better code?" and "How can we establish a consistently high quality level throughout the life cycle of the code?"

Software affects the day-to-day operations of businesses more than any other technology. If software fails, it can have massive economic implications. It may even cause severe damage and possibly kill people.



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"It's bizarre that there are engineering societies, medical boards, and bodies of accountants to ensure that people who perform these services meet certain standards, yet there is no equivalent for software development," says a correspondent for a software-quality newsgroup.

"If software companies want to make code more reliable, improving development processes is a must," says Henk Bakker of technology consultancy Ovum.

"Quality management has worked for many industries. Why shouldn't it work for software productions as well?," asks Martin Rösch, managing director of Rösch Consulting, a German software training and quality consultancy.

What Is Quality?

Although the definition of software quality isn't always clear or consistent, most project managers agree that there are four determinants of software quality: usability, stability, documentation, and maintainability. The weighting of these factors depends on corporate philosophy.

"The folks on the line want usability to be high. System administrators may be more interested in stability. The accounting group may be concerned with maintainability and cost-effectiveness," says Shel Prince, software consultant at CenterLine Software. Frank Walter, quality manager at Softlab, agrees: "Software quality should be defined by the application. In some cases, maintainability may have the highest priority; in other cases, it's usability."

Process vs. Technology

Conventional wisdom says that CASE methodologies, configuration management, software testing, and problem-tracking techniques may improve the overall quality of code. However, studies such as the European Software and Systems Initiative's "Best Practice in Software Development" reveal that to consistently achieve higher quality, the introduction of new technologies into software development must also be accompanied by the implementation of Process Improvement Models, or PIMs. (See the text box "Process Improvement Models" on page 40IS 17.)

PIMs and quality-assurance schemes for software development have become increasingly popular over the last five years. The two main programs in this area are the Software Engineering Institute's (SEI) Capability Maturity Model (CMM) and the ISO-9000-3 quality standard. Companies in the U.S. primarily use the CMM, whereas European companies more often install ISO-9000-3-compliant schemes. Some derivative and companion quality-assurance frameworks are also in use (see "Process Improvement Models").

The ISO-9000 quality-assurance program has gained much credit in such industries as manufacturing and service. It is popular in these industries because in many cases, ISO-9000-certified companies achieved a consistently high quality level and also managed to reduce their costs.

This suite of quality programs falls into three standards: ISO-9001, 9002, and 9003. ISO-9002 and 9003 target manufacturing and production industries and are therefore not relevant

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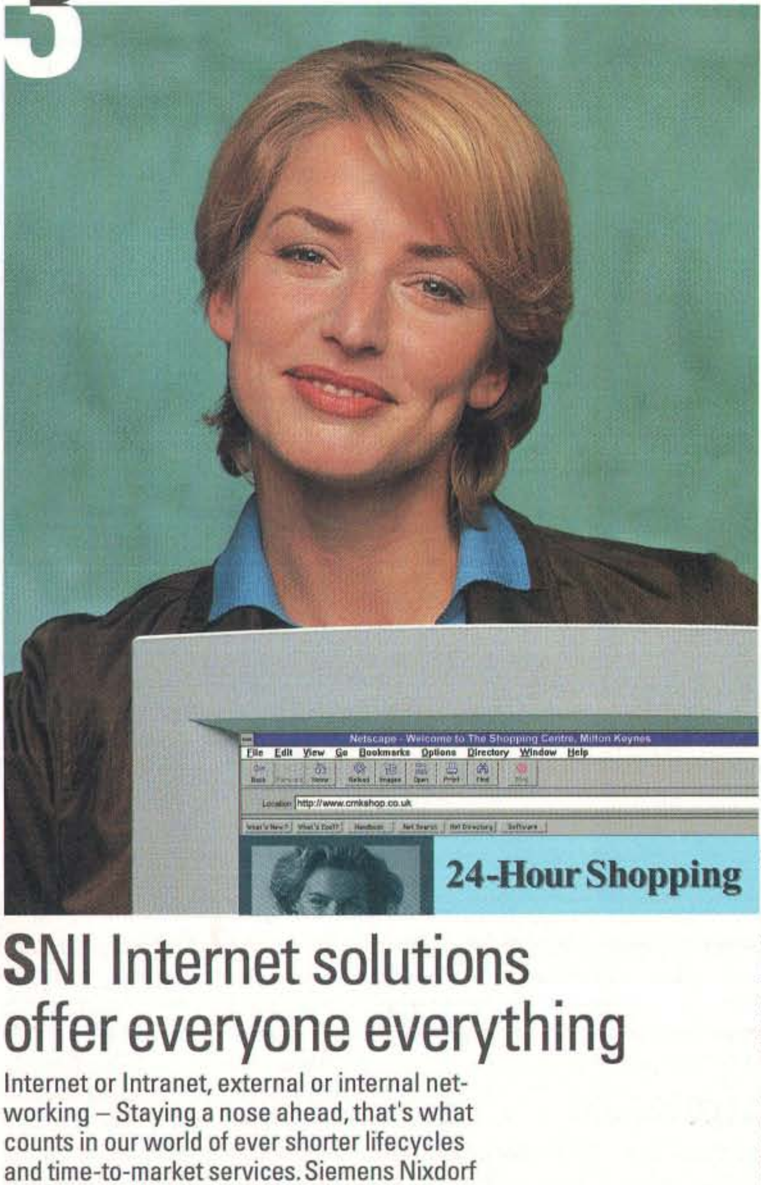
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for software production. ISO-9001 aims at all industries in general, including software production. However, early in this decade, the ISO issued the 9000-3 guidelines, which deal specifically with the requirements of the software industry.

The CMM is a derivative of U.S. Department of Defense guidelines. It is a key component of the successful bidding process for companies wishing to win defense and other government contracts. Bill Curtis, a former leader of the CMM project, says CMM is "an evolutionary method of continuous process improvement." The CMM organizes these evolutionary steps into five maturity levels. These levels

Process Improvement Models

The two most-often-used Process Improvement Models (PIMs) are ISO-9000-3 and the Software Engineering Institute's Capability Maturity Model (CMM). Other schemes (e.g., Bootstrap, TickIT, and SPICE) are derivatives of ISO-9000-3 and the CMM.

TickIT originated in the U.K. in 1991 under the sponsorship of the country's Department of Trade and Industry. It is a guideline for the implementation of ISO-9000-3. It addresses issues of specification, design, development, installation, and support of software. TickIT is frequently used as a requirement in supplier selection.

Bootstrap builds on the CMM model. It was developed from one of the EC's ESPRIT projects and is administered by the Bootstrap Institute in Brussels, Belgium. After an initial assessment from which an improvement scheme is developed, independent assessments are carried out on a regular basis. Various software tools help implement the self-assessment stage of this PIM.

SPICE (which stands for Software Process Improvement and Capability Determination) works both as a means of assessing process capability and as a PIM. It is also a method of bringing into line the other assessment methods. Using a five-capability-level categorization, SPICE is the new boy on the block. It is still undergoing trials at companies of varying size throughout Europe. This is being done to determine its worth as an ISO standard.

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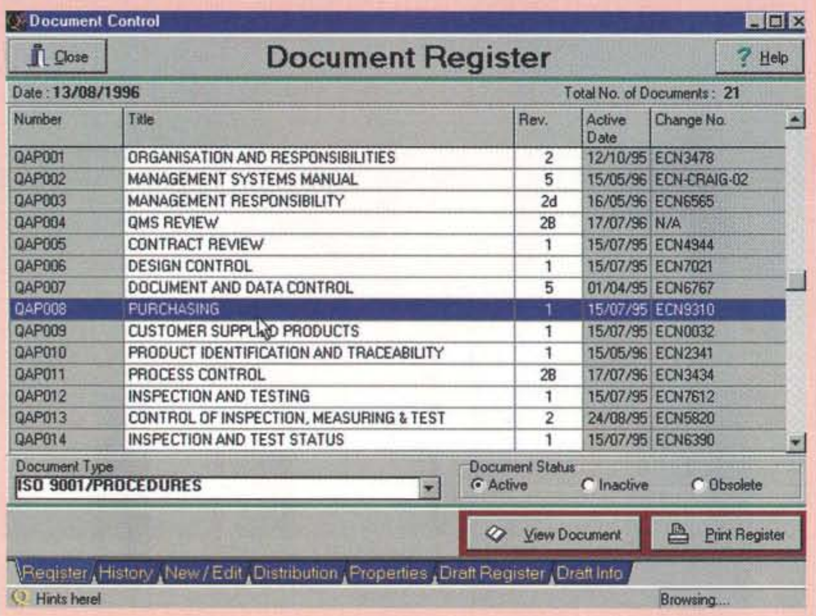
Software for Quality Management

Quality standards such as ISO-9000 force companies to better structure and control their business processes. A few software tools support this formal approach and help companies implement and operate an ISO-9000 scheme. Ruedlinger Engineering Systems' QualityMan and Gael Quality's Q-Pulse, for example, are generic quality management tools for Windows. They work in all relevant industry sectors such as manufacturing, health care, and utilities.

QualityMan 4.1 Professional is a "do-it yourself" tool for implementing, managing, planning, and auditing ISO-9001, 9002, or 9003 quality systems. The package includes a sample quality system that automatically adjusts to suit a user's business when based on company-specific information. Whereas QualityMan concentrates more on ISO-9000 implementation, Q-Pulse controls information work flow in existing quality schemes. It comprises a range of management-review facilities, identifies performance trends, and highlights problem areas.



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Number	Title	Rev.	Active Date	Change No.
QAP001	ORGANISATION AND RESPONSIBILITIES	2	12/10/95	ECN3478
QAP002	MANAGEMENT SYSTEMS MANUAL	5	15/05/96	ECN-CRAIG-02
QAP003	MANAGEMENT RESPONSIBILITY	2d	16/05/96	ECN6565
QAP004	QMS REVIEW	2B	17/07/96	N/A
QAP005	CONTRACT REVIEW	1	15/07/95	ECN4944
QAP006	DESIGN CONTROL	1	15/07/95	ECN7021
QAP007	DOCUMENT AND DATA CONTROL	5	01/04/95	ECN6767
QAP008	PURCHASING	1	15/07/95	ECN9310
QAP009	CUSTOMER SUPPLIED PRODUCTS	1	15/07/95	ECN0032
QAP010	PRODUCT IDENTIFICATION AND TRACEABILITY	1	15/05/96	ECN2341
QAP011	PROCESS CONTROL	2B	17/07/96	ECN3434
QAP012	INSPECTION AND TESTING	1	15/07/95	ECN7612
QAP013	CONTROL OF INSPECTION, MEASURING & TEST	2	24/08/95	ECN5820
QAP014	INSPECTION AND TEST STATUS	1	15/07/95	ECN6390

Document Type: ISO 9001/PROCEDURES

Document Status: ● Active ○ Inactive ○ Obsolete

Q-Pulse controls ISO-9000 implementation in various industry sectors.

define an ordinal scale for measuring process maturity and evaluating process capability. They contain guidelines that are designed to help an organization prioritize its improvement efforts.

Cost Overruns

The major factors that have plagued the software industry in recent years are cost and schedule overruns as well as failure to meet the expectations of end users. The CMM and ISO-9000-3 are intended to help eliminate these problems. However, many software-development firms—especially smaller ones—wonder about the complexity and cost-effectiveness of implementing these standards. Put another way, how much does it cost to implement high quality standards?

One answer to this concern comes from Cynthia Priscilla Rahardja at Embry-Riddle Aeronautical University (Daytona Beach, FL). She says, "Successful past processes can become base models to assist in planning and scheduling future projects, and to guide in meeting deadlines, saving on costs, and increasing efficiency and productivity." Her conclusion is that the goal is to make project success repeatable and to provide the customer with confidence that the quality is being implemented permanently.

Many international organizations such as Citicorp, Eli Lilly, Schlumberger, and Motorola have adopted the CMM, because its key practices and evolutionary approach to continuous improvement make sense in their environments. Even in Europe, some major companies such as Lloyd's Bank, Ericsson, Siemens, Philips, Alcatel, and

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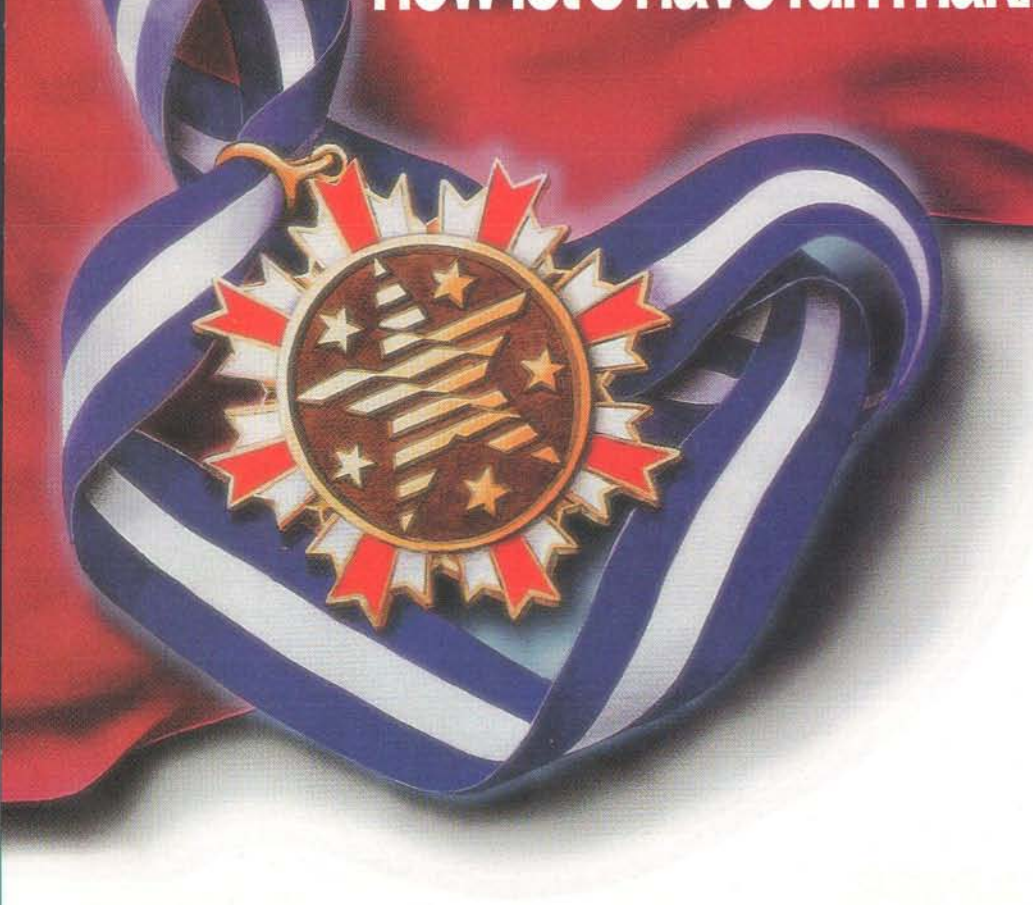

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Iberia have adopted the CMM to guide the continuous improvement they need to survive in their competitive markets.

On the other hand, ISO-9000-3 is gaining strength in the U.S. This newfound popularity is due, in large part, to multinational companies preferring to deal with only one standard. For them, ISO-9000-3's international acceptance is a clear advantage.

Implementing ISO-9000

Frank Walter of Softlab, an ISO-9000-certified software publisher, says, "ISO-9000 is a helpful guide to think about your own organization and processes." Walter believes it forces more documentation and leaves enough freedom for individual tailoring. On the other hand, he says, it sometimes becomes inefficient overhead for small projects. He admits that being in ISO-9000 conformance does not assure a high-quality product, nor does it necessarily "reflect customer satisfaction."

Project managers sometimes negligently treat the concept of ISO-9000 as "document what you do, and do what you document." According to Martin Rösch, however, trying to turn ISO-9000 into a document management system is a big error. "There is still a widespread belief that controlling all the paperwork of a project is enough. But that's a misconception because the only effect is an increase in administrative staff."

Rösch also emphasizes that turning ISO-9000 into a set of job descriptions isn't appropriate either. He recommends that during implementation, users follow these six steps that are derived from the ISO-9000 quality requirements:

➊ Make sure all requirements are stated in writing.
➋ Get the test cases that will be used to verify the requirements.
➌ Build an object-oriented analysis (OOA) model.
➍ Build a prototype for the functions of the new system.
➎ Run the test cases against the prototype.
➏ If all the expected results appear, you' re done. Otherwise, repeat.

Rösch says this procedure helps a company to avoid errors during the analysis phase and also makes it easier to include any new requirements. He adds, "The best blueprint for a programming task is a running program."

ISO-Compliant Tools

Tools such as Softlab's Software Engineering technology (Setec) help you develop software according to ISO-9000-3. They include a detailed process model and standards for all results of developing activities. However, not everyone has faith in a software solution. As Bill Curtis explains, "There are many process-definition tools, but the tools are not what create the benefits."

One of the best ways to fail, Curtis says, is for someone to go off and define a collection of processes and then tell everyone else to use them. Similarly, Mark Paulk of SEI notes, "An emphasis on tools misses the point. Software development is a human activity. Quality standards deal with the people."

Although some quality managers see the CMM as technically overengineered, a CMM-compliant quality system is in many respects much more advanced than an ISO-9000-3-compliant system. Curtis says, "ISO-9000-3 establishes a minimum quality program for a software organization. The CMM establishes a continuous

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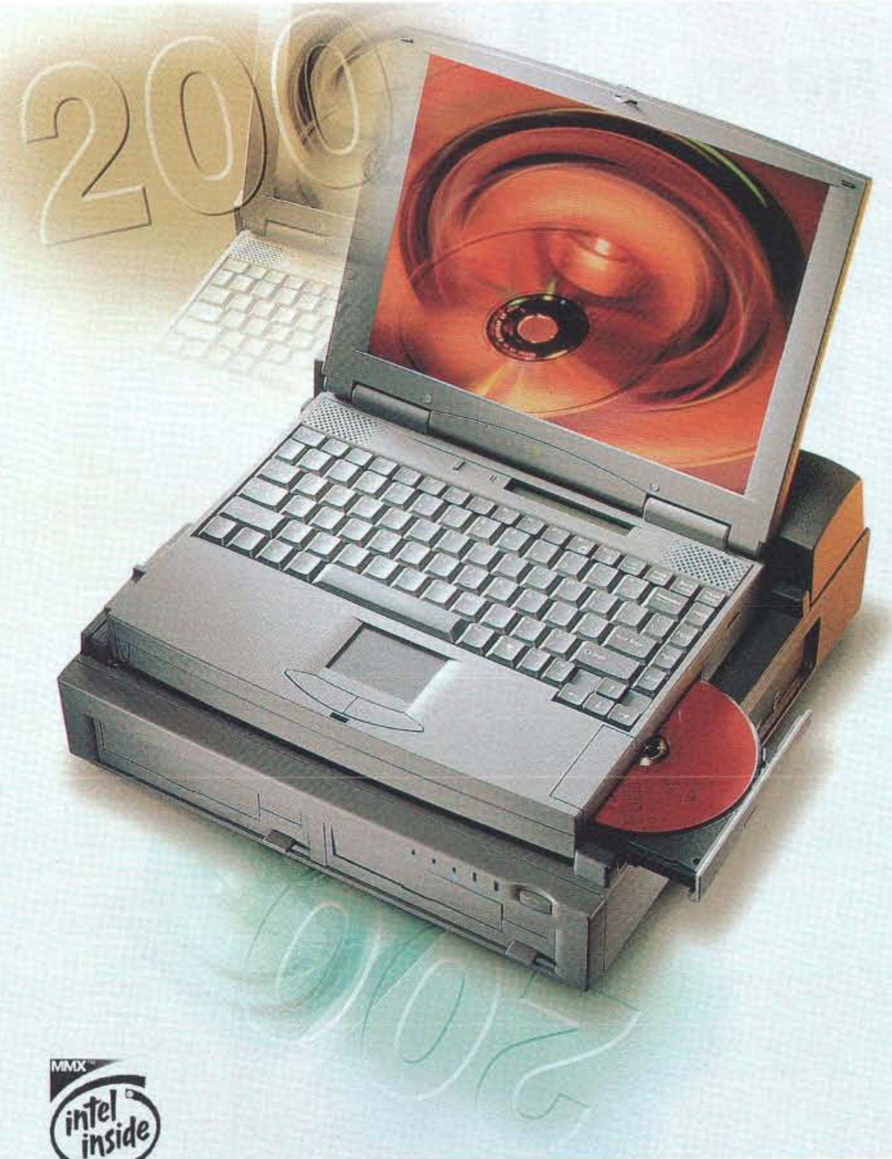

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improvement focus." Whereas ISO-9000 deals with issues of quality control and quality assurance, the CMM talks about the maturity of the process.

Rob Kantner, author of several books on ISO-9000, notes, "After all, there is nothing magical, and there is no rocket science, about the ISO-9000 requirements. They are simply good common sense."

Says Shel Prince of CenterLine Software, "Any organization should understand where it sits in the CMM paradigm, since this will allow them to predict future outcomes."

Areas for Improvement

The CMM uses both an internal assessment and a capability evaluation in determining certification. In an internal Software Process Assessment (SPA), software developers can evaluate their software's maturity and identify key areas for improvement. Professional external evaluators then perform audits according to the Software Capability Evaluation (SCE) to identify qualified contractors and to monitor existing software processes.

On the other hand, the ISO audits, performed by third-party certification bodies, ensure that procedures are in place for all quality elements, that the procedures have been followed, that the document-control scheme is valid, and that internal audits and corrective actions have been performed. While the CMM is a continuous process, many industry experts agree that one of the ISO-9000 auditing system's biggest drawbacks is that organizations often tend to take a static view of processes and therefore fail to achieve any real benefits from their improvement program.

More Mature Software

Last year, CenterLine Software commissioned a survey on the importance of software quality. It examined such issues as software testing and the types of tools employed in the testing. The survey results show that inadequate testing policies are often in place and that quality practices in software development lag behind those that are now commonplace in more mature industries such as manufacturing. Thus, one of the most important attributes of ISO-9000-3, according to CenterLine's Prince, is "it encourages organizations to think about quality in a formal way." This may lead to a more mature software industry. ■

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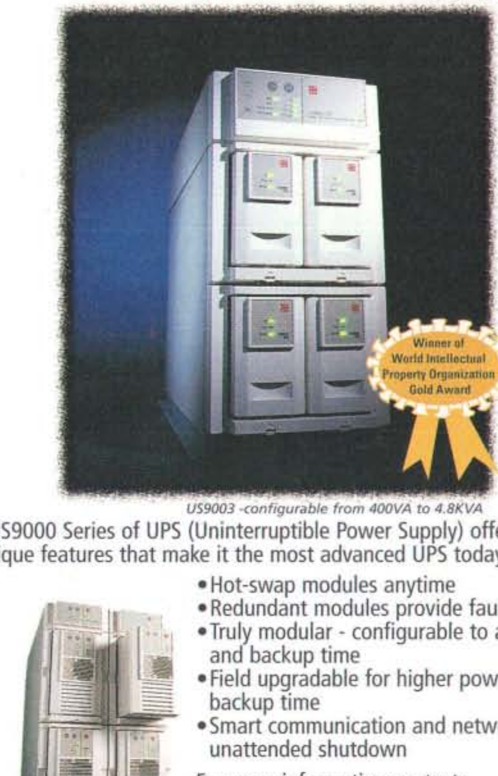

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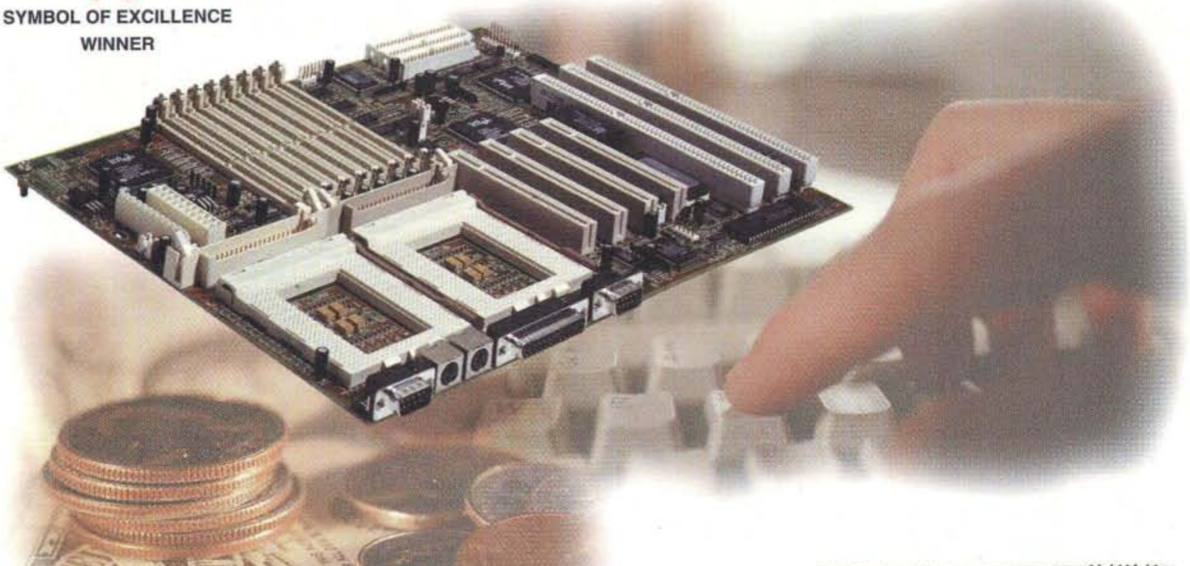

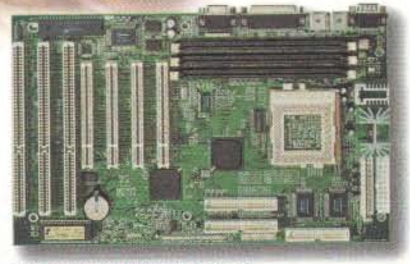

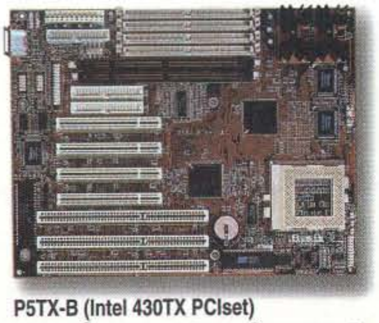

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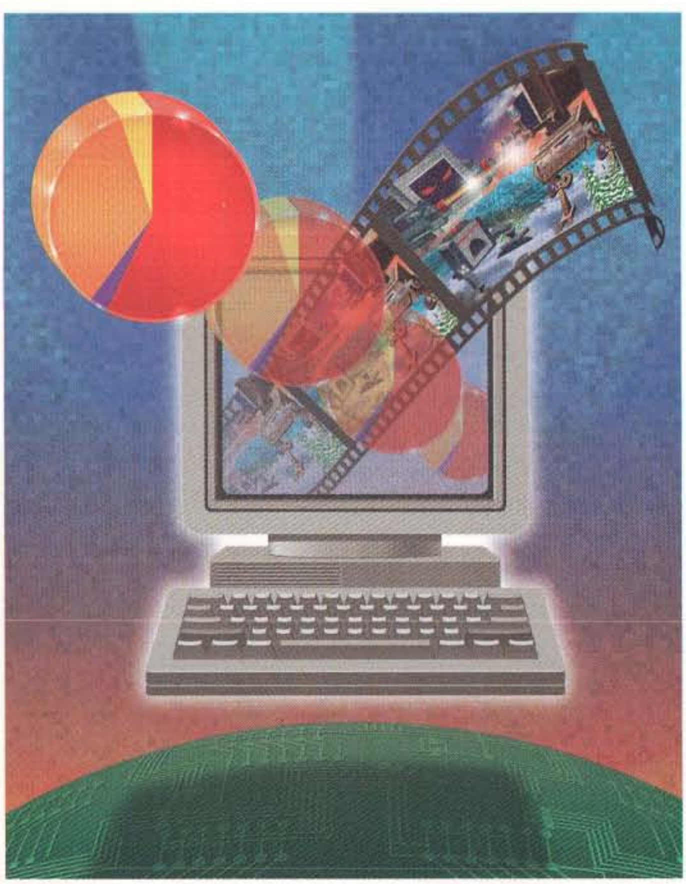
Next-Generation Multimedia Desktops

New bus architectures and chip sets support full-motion video and 3-D graphics.

By Nebojsa Novakovic and Mark Carroll

Last year, a significant new development occurred in PC performance standards. In addition to the usual set of integer, floating-point, graphics, and I/O benchmarks, multimedia functionality became recognized as a key performance criterion. And that means *real* multimedia, with real-time compressed video decoding and encoding, plus realistic MPEG-2 video with Dolby AC-3 surround-sound audio for digital videodisc (DVD). This happened simultaneously with the rapid spread of entertainment 3-D graphics to high-end home PCs.



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By the end of this year, every new PC that's shipped should have some degree of 3-D graphics and video features built in. Actual performance and feature sets will depend on a number of hardware and software factors.

Processing Power

The ability to offer interactive 3-D graphics and motion video while running other simultaneously launched applications in preemptive multitasking environments, like Windows NT, demands a lot of processing horsepower. Intel claims that its CPUs will be able to handle the majority of the load.

Expect an MMX-enabled P55C-200 Pentium to be the minimum requirement for a multimedia desktop CPU by the end of this year. With the help of MMX instruction extensions, the P55C can easily handle a 33.6-Kbps software modem, MPEG-1 decoding at 30 frames per second, or low-resolution videoconferencing by itself.

Of course, this assumes a system with sufficient cache and memory subsystems to provide enough bandwidth (528 MBps for 64 bits, a 66-MHz external cache, and a 264-MB minimum for 64-bit, 33-MHz extended data out [EDO] DRAM). MPEG-2 decoding with Dolby AC-3 sound, a common DVD requirement, necessitates a graphics/multimedia accelerator on a 200-MHz P55C system if smooth 30-fps playback is desired.

But MMX alone cannot provide significant help for 3-D graphics. According to Vivian Lu, product manager for First International Computer (FIC), MMX increases 3-D performance by only about 20 percent. A 3-D chip is still necessary even with MMX, especially when an Intel P5–level chip set is used. Stepping up to the P6 chip level opens up more possibilities, however.

MPEG-2 Decoding

Klamath, Intel's MMX- and Accelerated Graphics Port (AGP)–enhanced Pentium Pro, is expected to easily provide enough horsepower to handle MPEG-2 decoding and sound for DVD playback. This is due not only to its 50 percent to 60 percent higher processing power (266 MHz with a 512-KB cache versus a P55C-200's 512-KB external synchronous burst cache) but also to its second-level cache, which is twice as fast as that of the P55C. With a floating-point performance over twice that of the P55C (up to 266 MFLOPS at 266 MHz), Klamath also has the ability to handle more 3-D geometry setup tasks during rendering, achieving a software-rendering speed up to an estimated 400,000 shaded polygons per second.

Intel currently has no plans to support AGP at the Pentium level. Arthur Pai, director of desktop product management for Acer, says that "third-party core-logic vendors, such as VIA and Opti, will offer AGP-capable chip sets." This is potentially a very important development, particularly for home users. Pai adds that, with AGP, motherboard makers will be able to use sim-

Multimedia Instructions: The CPU Acts Like a DSP

Sun Microsystems was the first company to introduce CPU multimedia features, with its Visual Instruction Set (VIS) for its UltraSparc CPU. Now all major processor architectures (except PowerPC) have defined multimedia instruction extensions, which vary somewhat in scope and feature sets. These instructions accelerate calculations and make most 2-D and 3-D graphics and/or video, audio, voice-processing, and data communications tasks up to several times faster.

So-called multimedia extensions are actually instructions that deal with arithmetic and logic operations. These are done on packed data types, such as 8- by 8-bit bytes, 4- by 16-bit words, or 2- by 32-bit doublewords, all packed inside one 64-bit quadword.

Integrated Processing

Based on the single instruction/multiple data (SIMD) principle, multimedia extensions can process multiple sets of small operands and obtain multiple results with a single instruction. Operations include packing and unpacking, arithmetic, comparisons, logic, shifting, and (on SPARC and Alpha machines) motion estimation for motion-video encoding. The ultimate goal is the integrated real-time processing of multiple audio, video, and 2-D and 3-D graphics streams on a system CPU, although time is still needed to attain that level of performance.

Several multimedia extensions have been announced thus far: Matrix Manipulation Extensions (MMX) for the Intel x86, VIS for SPARC chips, Motion Video Instructions (MVI) for Alpha processors, and Mips Digital Media Extensions (MDMX) for Mips processors. Intel's MMX focuses on augmenting the old, outdated x86 architecture so that it can handle basic multimedia. VIS, MVI, and MDMX build on more-solid RISC architectures with three-operand instructions and large sets of 64-bit registers (which are already present) to facilitate multimedia tasks.

On Intel's P55C and Klamath chips, the ALUs and eight 64-bit media registers are shared with the FPU, so MMX and floating-point instructions cannot be processed simultaneously. This is a problem during rendering operations, where the FPU is doing geometry calculation and MMX instructions are simultaneously trying to do texture mapping. Frequent switching between floating-point and MMX modes can impair performance.

With the Alpha, on the other hand, the 32 64-bit integer registers handle multimedia operations simultaneously with other integer instructions. Sun's VIS is similar to Digital Equipment's MVI in that it enables operation on an entire 4-by-4 matrix directly to its 32 registers, compared to only eight registers for Intel's MMX.

MMX2

Intel's current MMX is primarily focused on image, audio, and video processing. Intel is expected to introduce in the first half of 1998 the MMX2 set of instructions for the planned Katmai Pentium Pro processor. The 0.25-micron-line-width Katmai, running at up to 400 MHz, should have a 2- by 32-KB cache and offer faster floating-point performance than its MMX-only, 2- by 16-KB-cache sibling, Deschutes.

How? Because the MMX2 will focus on floating-point-intensive 3-D graphics acceleration, and thus have much heavier memory demands. In fact, MMX2 is expected to have extensions that are very similar to the new MDMX extensions for future Silicon Graphics Mips processors.

plified, inexpensive 3-D chips that, along with AGP, will provide good 3-D performance. "S3, ATI, and Cirrus Logic are all now working on chips that utilize AGP and hence will have simplified feature sets at a low price," he explains.

The key competing x86 processors, AMD's K6 and Cyrix's M2, also have MMX instruction extensions and AGP, as well as accelerated floating-point performance that's close to the Pentium Pro level while keeping the standard Pentium pin-out. The use of a K6 or an M2 chip along with third-party AGP core logic opens the possibility of a less-than-$1200 multimedia PC with 3-D video and audio.

System I/O Bus

Two years ago, it looked like the 32-bit, 33-MHz, 132-MB PCI bus would provide more than enough bandwidth for any use. But that was before 3-D graphics and motion video entered the mainstream—not to mention faster disk interfaces, such as the new 80-MB Ultra2 wide SCSI and the 200-MB dual-port Fibre Channel–Arbitrated Loop (FC-AL).

To prevent another occurrence of I/O choking similar to what happened with ISA-bus-equipped 486 PCs, two complementary strategies have since been used to create more bandwidth. The first was to expand PCI to a 64-bit width (264-MBps peak bandwidth with 8-KB bursts at 33 MHz). The second strategy was to double the clock rate to 66 MHz, for a peak bandwidth of 528 MBps.

However, at 66 MHz, PCI can reliably support only three to four loads (and two slots at most) per bus compared to 10 loads (five slots, or four slots and a bus bridge) per bus for PCI at 33 MHz. It also requires an additional regular PCI bus in

CPU Comparison

A comparison of 1997 multimedia-enhanced processors for the Windows NT environment. Data is based on estimates as of January 7. (Source: Intel)

	Intel P55C	**Intel Klamath**	**Intel Deschutes**	**AMD K6**	**Cyrix M2**	**Digital 21164PC**	**Digital 21264PC**
Processor frequency (MHz; maximum)	200	266	300+	200	225	533	600+
Cache bus (bits)	64	64	64	64	64	128	128
Cache frequency (MHz; maximum)	66	133	150+	66	75	177	400+
Memory bus (bits)	64	64	64	64	64	128	64
Memory frequency (MHz; maximum)	66	66	100	66	75	100	400+
Instruction issue	2	3	3	2	2	4	4
Peak instructions per cycle	2	5	5	4	2	4	6
Estimated SPECint95	6	10	12	N/A	N/A	15	40
Estimated SPECfp95	5	8	10	N/A	N/A	19	60
Multimedia extension	MMX	MMX	MMX	MMX	MMX	MVI	MVI
Operands	2	2	2	2	2	3	3
Multimedia registers	8 FP	8 FP	8 FP	8 FP	8 FP	32 INT	32 INT

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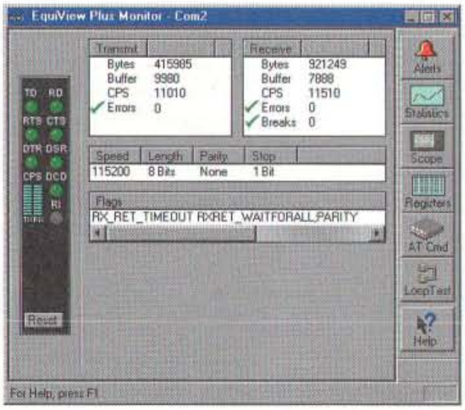

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Dedicated Graphics Chips for Multimedia Processing

While Intel pushes CPUs and simple DSP chips as the solution to this year's PC multimedia needs, readily available dedicated 3-D graphics chips might be just as viable a solution. The new entrants in the mainstream 3-D PC arena all offer combined 2-D, 3-D, and video acceleration.

With the rapid graphics and motion-video technology changes that are now occurring, companies previously oriented toward the low end now have new high-end offerings, and previously high-end vendors are now expanding into the mainstream. For example, Trident Microsystems, traditionally a low-end-solution provider, now offers one of the best PC graphics accelerators around. Its $37.50 (in quantities of 1000) 3DImage 985DVD 3D+ digital videodisc (DVD) graphics processor uses the fastest 133-MHz version of Intel's AGP bus.

Trident's CADE3D technology, used in the 3DImage 985DVD, achieves a peak 1.2-million-polygon-per-second (60 megapixels per second) 3-D rendering rate while storing the textures in main system memory. This is over twice the speed of 3DLabs' Permedia.

The 985DVD also has an on-chip 3-D geometry setup to off-load a big slice of the 3-D computations from the floating-point-weak Pentium CPU. The built-in, full-motion DVD video support runs at 30 frames per second with Dolby AC-3 surround sound. The chip can work collaboratively with an MMX-enabled Pentium or Pentium Pro to off-load to the CPU up to 50 percent of the DVD playback tasks with MPEG-2 decompression and image-enhancement hardware.

Graphics Chip Race

ATI, Cirrus Logic, Matrox, Rendition, S3, 3DLabs, and VideoLogic are all in the race to offer a winner in the graphics chip market. Most of them will also begin to support AGP by the middle of this year. For now, standard performance is equal to that of S3's 86C385 ViRGE/GX processor. This chip uses up to 8 MB of synchronous graphics RAM (SGRAM) clocked at up to 100 MHz with standard trilinear filtering, MIP mapping, transparency, and effects. It also provides better motion-video acceleration than previous graphics chips.

Other important entrants in the Windows NT power-desktop 3-D graphics arena include 3DLabs, the current market leader, with its GLiNT 500TX rendering chip and the companion GLiNT Delta geometry processor; Intergraph, with its RealiZM and Intense3D cards; Dynamic Pictures, with its Oxygen family; and Evans & Sutherland, with its REALimage cards, which use Mitsubishi's 3D-RAM technology. The majority of these processors are expected to support the AGP bus on Intel platforms and Alpha's platform for the Windows NT environment by year's end, although some will also support 64-bit extended PCI for systems without AGP.

At the high end of the market, one particularly interesting entrant is Real 3D, a Lockheed Martin company, which has teamed up with Intel to design a new generation of AGP 3-D graphics processors optimized for Pentium Pro systems. The current Real 3D/100 two-chip PCI chip set is aimed at high-end power desktop graphics and achieves up to 750,000 shaded, textured polygons per second by integrating a geometry-transformation engine with a rendering and texture processor.

Another entrant, Intel and its forthcoming chip (code-named Auburn), looms as a strong competitor to other graphics chips. Auburn is evidence that even Intel doesn't believe that CPUs can handle the demands of 3-D video.

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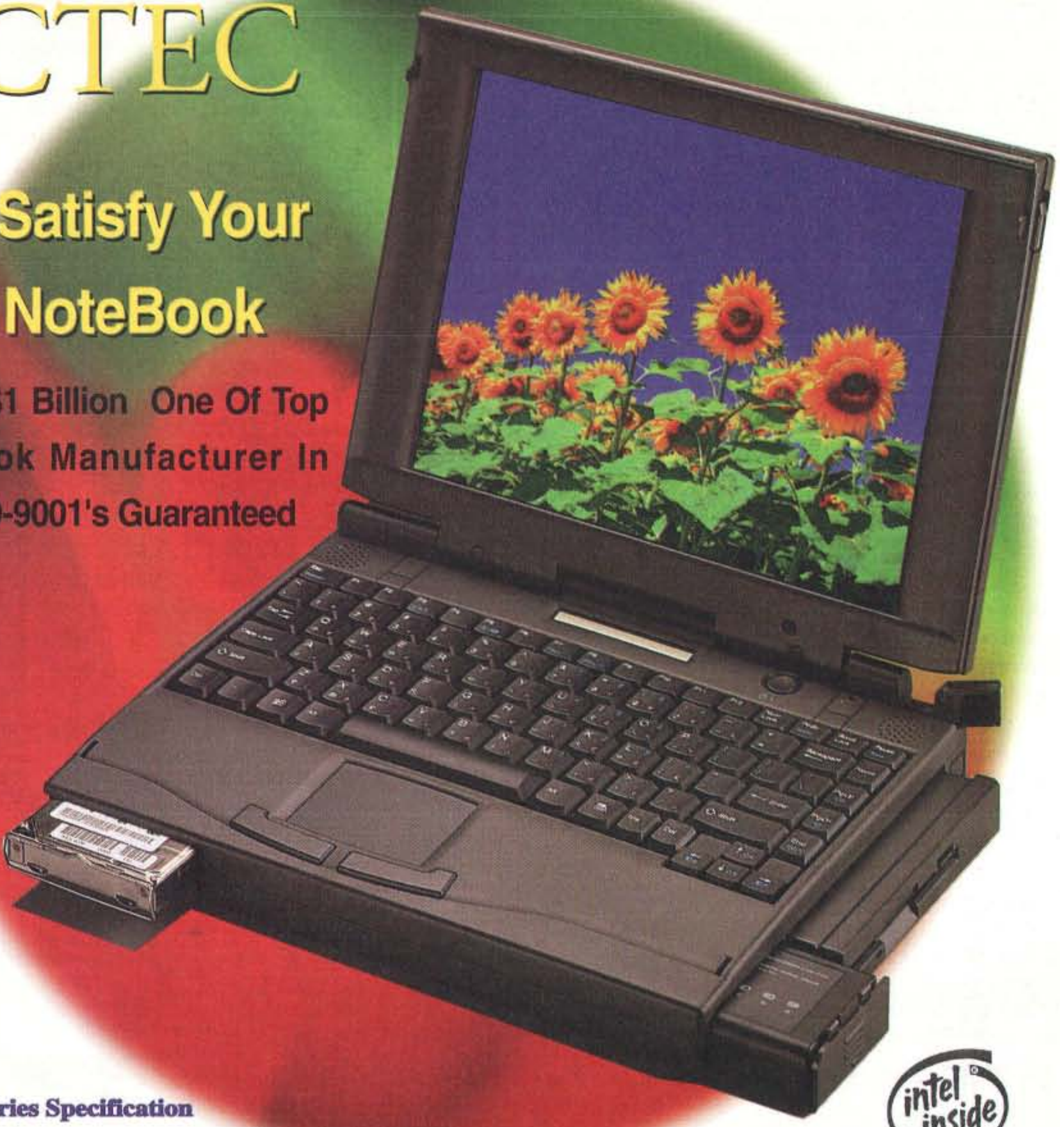

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Circle 741 on Inquiry Card (RESELLERS: 742) the system for less-demanding cards. Thus, having two PCI buses simultaneously and independently attached to the main memory bus is what effectively doubles the total I/O bandwidth.

Intel's AGP

The newest solution to the bandwidth problem is Intel's AGP. A separate graphics point-to-point connection based on a revision of the PCI 2.1 specification, AGP includes bidirectional bus traffic, read queuing, and DMA mastering, all operating in parallel with the system's main PCI bus. This 32-bit bus runs at 66 MHz, using dual-edge clock transfers to move data on both sides of the clock edge for an effective throughput of 133 MHz, producing a peak bandwidth of 528 MB.

This bandwidth is necessary if a 3-D graphics chip is accessing the texture data from main memory—the main purpose of this bus. Uncompressed motion-video manipulation will also welcome that bandwidth. AGP will first be implemented in Intel's 440LX chip set for Klamath, which is expected to be announced this summer.

As the days of standard DRAM draw to a close with the advent of synchronous DRAM (SDRAM), Rambus DRAM, and other new memories, the solution for the main-memory speed problem might finally be here. What kind of memory bandwidth will new desktops need to satisfy 3-D and motion-video requirements?

Again, Pentium-class systems using a P55C, K6, or M2 will become the baseline. Using the new Intel 430TX (or the similar Opti, SiS, or VIA chip sets), these systems will have 64-bit SDRAM main memory, offering a peak burst bandwidth of 528 MB at 66 MHz (or 600 MBps on the 75-MHz bus of the 225-MHz Cyrix M2). Pentium Pro systems, including those based on the new Klamath, will have the same peak main-memory bandwidth as current Pentiums, but with a deeper bus pipelining.

At the end of this year, the 300-MHz Deschutes, racing at 100 MHz to provide a peak bandwidth of 800 MB, will bring a faster system bus to the Pentium Pro world. Klamath, Deschutes, and other future Intel processors will have a key advantage over the Pentium: an AGP graphics bus closely tied to the main memory bus.

The need for AGP as a way around the requirement of huge amounts of video memory is significant. FIC's Lu says that "without AGP, 3-D video must go to 128 bits. That means that even 4 MB of video memory will barely be sufficient. Instead, you need to go to 1 MB of Rambus DRAM, as Cirrus Logic has done." But even with AGP, future3-D graphics might require Rambus DRAM. In fact, Intel has said that Rambus DRAM is the memory of choice for late 1998—not only on the video end, but for system memory as well.

Even with the appearance of $1200 3-D multimedia PCs, there remains a marketing problem: a lack of software for the platform. When Intel released its MMX technology, it could demonstrate only a handful of games that take advantage of the new instruction set.

FIC's Lu says that programmers' response to AGP is even more negative. If game-playing is what's driving consumers to 3-D, then the PC will remain at a distinct price disadvantage compared to game machines costing $200. **B**

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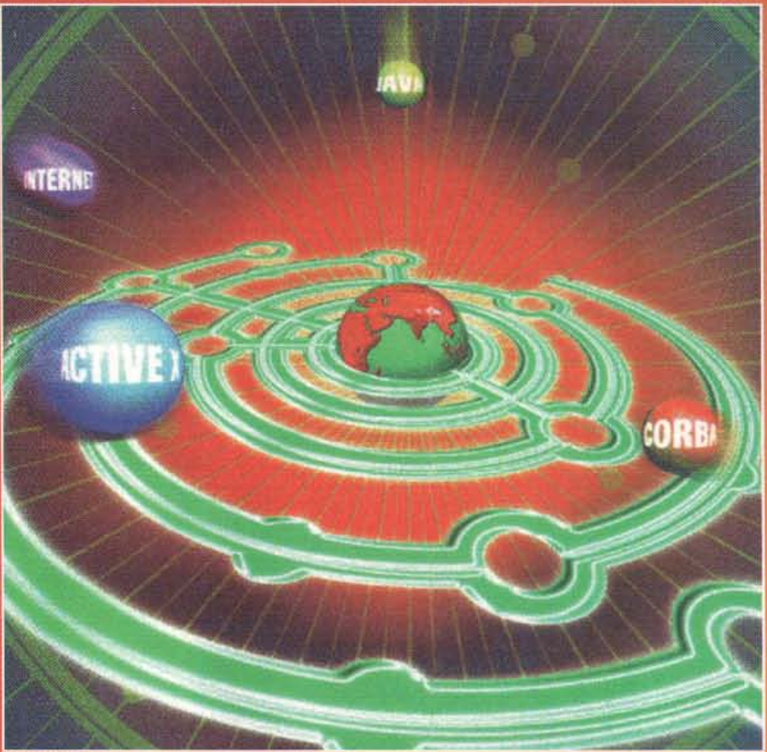

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CD Writer for Parallel Ports

Freecom's F-PCDR-2 is an external CD recorder that plugs into the parallel port of Windows 95, Windows 3.1, or DOS PCs and works reliably–at least if your PC's parallel port is fast enough. The package includes Gear, CD-recording software from Electroson (Eindhoven, The Netherlands) that supports standard CD-ROM, CD-ROM XA, and CD Audio formats as well as mixed audio and data and multisession recording. This multilanguage software (English, French, German, and Spanish) simulates a trial run before the actual burning process, so that you can check transmission times and format compatibility on the target CD.

The F-PCDR-2 supports 1× (minimal transmission rate of 150 Kbps) and 2× (300 Kbps) recording speeds and 4× read sessions. It works reliably if your PC features a high-speed parallel port or you record your CDs with 1× speeds. I tested the device on my P60 machine (16 MB of RAM) and on a state-of-the-art P200 multimedia PC (32 MB of RAM). The parallel ports of both machines featured an EPP configuration that the manufacturer sets as a minimum requirement for proper work. However, the 2× recording speeds worked only on the P200 multimedia PC. My tests revealed actual transmission times of about 170 Kbps (1×) and 340 Kbps (2×), respectively.

If your PC doesn't include a SCSI adapter, or if you use a mobile computer, the F-PCDR-2 opens a way to write CDs. Users of SCSI systems may prefer Freecom's dual-port (SCSI and parallel) CD writer, the F-DCDR-2, because it provides both options: higher-speed transmissions and parallel-port connectivity.

–Rainer Mauth

Monitors

Front-Mounted USB-Hub Monitors

IF YOU'RE TIRED OF HAVING TO POKE around the back of PCs and peripherals to make connection, Leo Systems offers two color monitors with an easy front-access USB hub. Named the ComfortView series, both 15- and 17-inch sizes are available. The 15-inch monitor has a 0.28-mm dot pitch with a horizontal frequency of 70 kHz and a vertical frequency of up to 100 Hz. Maximum resolution is 1280 by 1024 pixels. The 17-inch monitor has a 0.25-mm dot pitch. Maximum resolution is 1600 by 1200 pixels at a 65-Hz vertical frequency. Both monitors feature an OSD menu for 12 video settings. The USB hub has one upstream port (i.e., from the PC) and four downstream ports.

Price: Call company.
Leo Systems, Inc., Taipei Hsien, Taiwan, +886 2 918 6001; fax: +886 2 917 1769.
Circle 1040 on Inquiry Card.

21-inch Professional Monitor

VIEWSONIC'S 21-INCH PROFESSIONAL Series monitor, the P815, features a maximum resolution of 1800 by 1400 pixels with a 76-Hz refresh rate. For complete image control, it features ViewSonic's OnView on-screen menu and Viewmatch screen/printer matching technology. A 0.25-mm dot pitch combined with a 91-Hz refresh rate at 1600 by 1200 pixels is said to make the P815 easy on the eyes. Designed with CAD/CAM/CAE users in mind, the P815 is geared toward high-end graphics, production, science, and engineering applications. This makes it all the more robust for today's graphics-intensive home and office computing.

Price: Call company.
ViewSonic International Corp., Taipei Hsien, Taiwan, +886 2 248 4072;
fax: +886 2 246 8238;
vstech@viewsonic.com;
http://www.viewsonic.com
Circle 1041 on Inquiry Card.

High-Resolution 17-inch Monitor

MICROVITEC'S 17-INCH DESKTOP monitor, the Pro-Scan 17SX, operates at frequencies of up to 95 kHz, achieving a maximum resolution of 1600 by 1200 pixels at 75 Hz. It complies with Energy Star and Nutek power-saving standards, and MPR II and VESA DPMS requirements. By incorporating a high-resolution microfilter screen, the device has more brightness and contrast ratios.

Price: Call company.
Microvitec, Bradford, U.K., +44 1274 390011;
fax: +44 1274 734944;
http://www.microvitecplc.com.
Circle 1042 on Inquiry Card.

Mice

Rollerless Mouse

ATTENTION MOUSE-INDUCED TENDINITIS sufferers: Everton Technology has designed a mouse with no rollers. The WinPoint is anchored on an absolute axis coordinate that provides an overall range of movement of just 1.8 by 1.6 cm. As a result, the WinPoint requires only one-third the usage space of a roller-based mouse. Movement is not a problem, because the WinPoint can easily place the cursor anywhere on the monitor. Due to its rollerless design, the WinPoint requires no mouse pad and therefore is not susceptible to the evils of mouse-pad link. This mouse is designed for both left-and-right-handed users.

Price: Call company.
Everton Technology Co. Ltd., Taipei, Taiwan, +886 2 880 5858; fax: +886 2 880 6262; everton@tpts4.seed.net.tw.
Circle 1043 on Inquiry Card.

Communications

A PC Card for GSM Phones

PROVIDING COMPATIBILITY WITH MAJOR GSM phones on the market, the GSM-Wave PC Card communications card enables you to send e-mail, faxes, and SMS messages over the Internet. It supports phones from Nokia, Ericsson, Siemens, and Sony. The vendor claims that the same card will work on all GSM phones because of an upgradable EEPROM for the GSM-Wave.

Price: Call company.
X-Wave, Dordrecht, The Netherlands, +31 78 652 1142; fax: +31 78 652 1141; x-wave@wirehub.nl.
Circle 1046 on Inquiry Card.

ISDN Boards for Global Use

THE HARMONIX HI-CARD SERIES OF ISDN cards now includes PCI-bus versions for both BRI and PRI ISDN. The cards feature on-board channel aggregation, multilink PPP, and support for Windows 95, Windows NT, Mac OS, CAPI 2.0, LynxOS, and Phar Lap. They are fully approved for use in Europe, Asia, and the U.S.

Price: Call company.
Harmonix, Taunton, U.K., +44 1823 433711; fax: +44 1823 433722; Harmonix@Harmonix.co.uk.
Circle 1044 on Inquiry Card.

High-Speed Serial Communications Card

PROVIDING TWO INDEPENDENTLY CONFIGURABLE RS-232 ports, the Velocity 232 serial communications card achieves data transfer rates of up to 921,600 bps. It uses a 16750 UART with 64-byte FIFO buffers supporting multitasking OSes such as Windows 95, OS/2, and Windows NT. The card aims at driving high-speed modem and ISDN applications.

Price: £125.
Brain Boxes, Liverpool, U.K., +44 151 220 2500; fax: +44 151 252 0446; help@brain_boxes.cybase.co.uk; http://www.connect.org.uk/merseymall/brain_boxes/.
Circle 1045 on Inquiry Card.

Keyboards

Wireless Keyboards in Luminous Colors

YOU CAN OPERATE THE OTY WIRELESS IR keyboards at distances of up to 8 meters and at transmission angles of up to 45 degrees from the receiver. They include multichannel capability that lets you operate several computers either separately or simultaneously. These keyboards come in various color combinations and include a mouse-control program that lets the cursor be moved via arrow keys.

Price: Call company.
Strol Datentechnik, Detmold, Germany, +49 5231 954451; fax: +49 5231 954455; 101347.177@compuserve.com.
Circle 1047 on Inquiry Card.

Storage

On-Line Data Storage

THE VFD 16000 OPTICAL DRIVE PROVIDES 16 GB of on-line data storage. You can combine six of the removable WORM discs in one unit, for a total of 96 GB of storage space. You can couple two of the units in a jukebox to further extend capacity. The system features two independently controlled miniature heads that simultaneously read both sides of the medium, providing an average data transfer rate of 3.3 MBps.

Price: Call company.
ATG Cygnet, Toulouse, France, +33 5 62 142102; fax: +33 5 61 410349.
Circle 1048 on Inquiry Card.

Notebooks

Notebook with a 3.1-V Processor

THE CALIBRE PLUS NOTEBOOK USES INTEL'S SL Enhanced Pentium processor running at 3.1 V. This increases battery life and also reduces heat. The CPU speed is adjustable, offering greater control over battery life. The system deploys a PCI-bus architecture and works with IDE hard drives ranging from 810 MB to 2.6 GB. The display size is 11.4 inches.

Price: Call company.
Opti International, Barking, U.K., +44 181 507 1818; fax: +44 181 594 2235; 100517,2553@compuserve.com.
Circle 1049 on Inquiry Card.

Graphics

Pocket-Size TV Signal Converter

GRAND TELEVIEW, A POCKET-SIZE BOX computer-to-TV signal converter, allows the display of PC and Mac screens on NTSC and PAL TVs. It also connects to VCRs to record presentations and has a built-in audio amplifier, enabling you to make audiovisual presentations without additional hardware.

Price: £295.
Imagine Graphics, St. Albans, U.K., +44 1727 844744; fax: +44 1727 811660; 72132.502@compuserve.com.
Circle 1050 on Inquiry Card.

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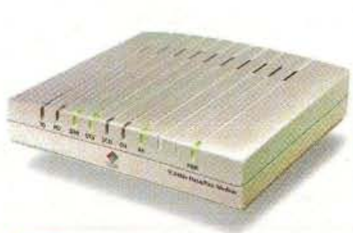

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New V.34bis 33,600bps SERIES

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- Supports windows 95

BABT REN-1 BZT FC CE

TA717

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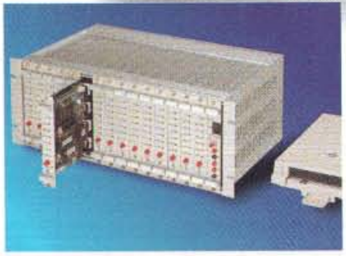

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Advanced Features:

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Advanced Features:

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E-Mail:service@ml.e-tech.com.tw

SOFTWARE

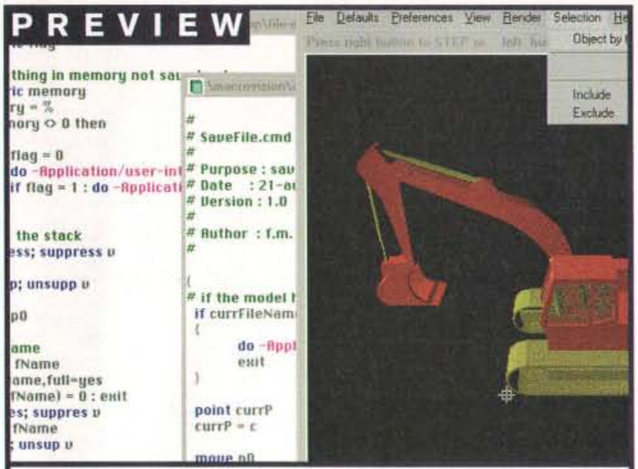
Customer Tracking

Japanese CIS Software

EAST HAS RELEASED A JAPANESE-LANGUAGE version of Pivotal Software's Pivotal Relationship, an enterprise-wide CIS application that consolidates all customer information in one system. It allows sales, marketing, customer service, and operations staff to target prospects, close sales, fulfill orders, and solve customer problems. It is the first 32-bit application that fully integrates Windows NT and Windows 95 desktop and mobile computers with Microsoft BackOffice database servers to create an affordable, adaptable system for managing customer interactions and relationships.

Price: Call company.
East Co. Ltd., Tokyo, Japan,
+81 3 3370 8846;
fax: +81 3 3374 2998;
pivotalinfo@est.co.jp;
http://www.est.co.jp
Circle 1056 on Inquiry Card.

PREVIEW



```
thing in memory not sa
ic memory
ry = %
nory <> 0 then

flag = 0
do -Application/user-int
if flag = 1 : do -Applicati

 the stack
ess; suppress v

p; unsupp v

p0

ame
 fName
ame,full=yes
fName) = 0 : exit
es; suppres v
fName
; unsup v
```

```
#
# SaveFile.cmd
#
# Purpose : sav
# Date    : 21-a
# Version : 1.0
#
# Author  : f.m.
#

(
# if the model h
 if currFileNam
 (
        do -Appl
        exit
 )

 point currP
 currP = c

 move p0
```

Volcano
Price: US$2000 per license

Circle 1054 on Inquiry Card.

MacroVision Creative Software
Dublin, Ireland
+353 1 6671111
fax: +353 1 6671418
macroVision@msn.com

Visual Programming for Engineers

With its Volcano applications framework for Windows 95 and Windows NT 3.51, MacroVision Creative Software brings easy software extensibility and components reusability into the realm of graphical applications development. Version 1.0 comes with a rich code base for 2-D and 3-D mechanical and architectural CAD as well as GIS applications. Although this code is general-purpose, the good thing about Volcano is that you can easily develop your own components based on existing code modules (i.e., components). These components are grouped into categories of classes and methods, but they don't provide for reuse of components via inheritance.

MacroVision has constructed this tool on its Eagle graphics kernel, which includes a high-level macro language. When you start a new project, the System Browser lets you pick components from the Volcano data dictionary. If you understand the Eagle programming language, you can simply drag the components into the Workbench Editor and adjust them to your needs.

You can also incorporate C/C++ programs and custom DLLs into Volcano's data dictionary and together with, for example, the Visual C++ compiler create executable files and DLLs. However, you can't write components to the OLE/ActiveX interface.

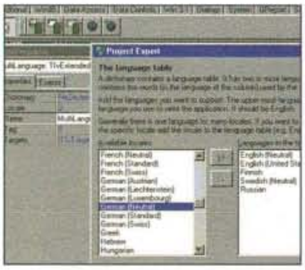
Volcano is a slick visual environment for engineers who want to develop graphic and spatial system applications for use in their corporations. Professional software developers who are not willing to learn a new macro language may, however, want to pass.

–Rainer Mauth

Development

Prolog for the Web

WITH THE LPA PROWEB SERVER, WEBsite developers can capitalize on the reasoning capacity of the Prolog programming environment running in the background. It hides the complexity of HTML forms and CGI programming, and, by handling all the communications between the forms and the application logic, relieves the programmer from irksome bookkeeping. Other features of the LPA ProWeb Server include session management and support for backtracking of errors.

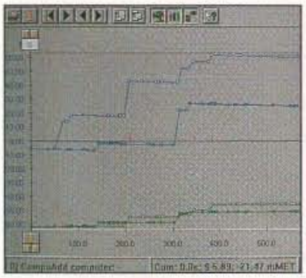


Price: Starts at US$495.
Logic Programming Associates, London, U.K., +44 181 871 2016; fax: +44 181 874 0449;
lpa@cix.compulink.co.uk;
http://www.lpa.co.uk.
Circle 1057 on Inquiry Card.

Image Editing

Web-Ready Image Editor

ULEAD SYSTEMS' LATEST OFFERING, PHOTOImpact with Web Extensions, is a powerful imaging editor for PC users. It features a multilevel interface for basic, intermediate, and advanced modes. The full range of image-editing features is available, including auto-processing, palette, style gallery, and album features. Plug-in effects supported include 16- and 32-bit APS, along with compliance to Kai Power Tools and Adobe Photoshop plug-ins. Among a long list of features, it supports button-imaging capabilities, 3-D text creation, an image map editor, and preloading resolution image-creation functions.



Price: US$139.
Ulead Systems, Inc., Taipei, Taiwan, +886 2 764 8599;
fax: +886 2 764 9599;
iano@ulead.com.tw;
http://www.ulead.com.
Circle 1055 on Inquiry Card.

Globalization Toolkit for Delphi

DELPHI DEVELOPERS USING INNOVIEW MULTIlanguage can produce international applications in a single process and a single program. The tool closely operates with Delphi and can save translated strings in text, a database, or an embedded dictionary. The package includes full source code, extended help files, and a demonstration program. Supported languages are English, French, German, Spanish, Italian, Portuguese, Danish, Swedish, and Finnish.

Price: £125.
Innoview Data, Helsinki, Finland, +358 9 47620550;
fax: +358 9 47620555;
info@innoview.fi;
http://www.innoview.fi/products/multi/.
Circle 1058 on Inquiry Card.

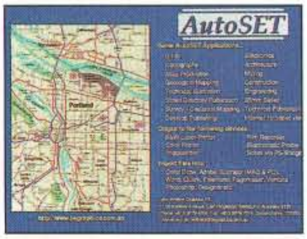
TeemCreator Converts Legacy to Client/Server Applications

TEEMCREATOR, A FRONT-END DEVELOPMENT tool, enables fast conversion of legacy or Unix applications to a client/server environment. By developing Windows or X11/Motif GUIs, users of existing applications can upgrade their software by distributing a run-time license. The tool features a 4GL designed to handle character-based screen formats.
Price: Call company.
Pericom Software, Milton Keynes, U.K., +44 1908 265533; fax: +44 1908 265534; http://www.pericom.co.uk.
Circle 1059 on Inquiry Card.

Graphics

CAD Package Supports CYMK

WITH AUTOSET 2.51, CAD USERS CAN map any CAD color to the CYMK color space and create output in standard graphics formats such as Adobe Illustrator, Freehand Corel Draw, and Acrobat PDF, as well as color-separation output. The tool also lets you render CAD entities from one layer several times into one output file.
Price: $345.
John Walker Graphics, Melbourne, Australia, +613 9879 4388; fax: +613 9879 7074; http://www.jwgraphics.com.au.
Circle 1060 on Inquiry Card.



OCX Views AutoCAD Drawings

THE ACADEMUS VIEW OCX LETS DEVELOPERS integrate viewing and printing of AutoCAD drawing files in Visual Basic, Borland Delphi, or Visual C++ applications. The standard edition of Academus View OCX supports AutoCAD SHX fonts, line types, and solids. It views model- and paper-space drawings. The professional version provides additional zoom and pan functionality and can send sections of a drawing to the Clipboard.
Price: Starts at DM 350.
Academus, Oslo, Norway, +47 22 627390; fax: +47 22 627492; academus@academus.no; http://www.riksnett.no/academus.
Circle 1061 on Inquiry Card.

Networking

Multiprotocol LAN Monitor for Windows

RUNNING ON ANY WINDOWS PLATFORM, JetLAN is an advanced network management tool that provides statistical information about LAN use. It breaks down network traffic by node, conversation across the LAN, and protocol statistics. A fully functional demonstration version is available on the Web.
Price: Call company.
Jaguar Communications, St. Albans, U.K., +44 727 898000; fax: +44 727 851245; http://www.jaguarcomms.co.uk.
Circle 1062 on Inquiry Card.

Security

Say No to Data Theft

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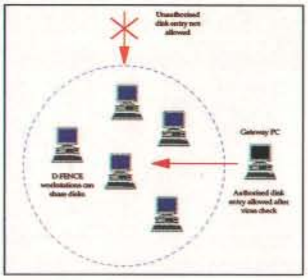
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of machine theft or during repair. It provides two options for controlling disk traffic entering or leaving the computer: encryption and authorization. It also allows the erased areas of floppy disks to be purged to prevent data being smuggled in and out of organizations via erased files.
Price: Call company.
Sophos, Abingdon, U.K.,
+44 1235 559933;
fax: +44 1235 559935;
sales@sophos.com;
http://www.sophos.com.
Circle 1063 on Inquiry Card.

Business

Cost Management Software for Windows 95/NT

PROVIDING A WIDE RANGE OF PERFORMANCE measurement techniques, Cobra 3.0 is a cost management application for commercial enterprises and government contractors. It works in combination with a project manager and scheduling tools to cover the complete life cycles of projects. You can save all reports in Excel format.
Price: Call company.
Welcom Software Technology, London, U.K., +44 171 401 2626; fax: +44 171 922 8865; http://www.wst.com.
Circle 1064 on Inquiry Card.

Communications

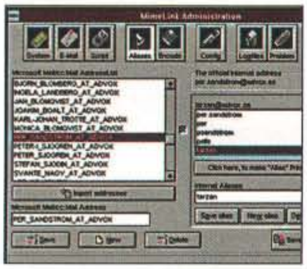
Mimelink Converts E-Mail into Internet Format

MIMELINK PROVIDES A TRANSPARENT INTERnet link for cc:Mail, Notes, and Microsoft Exchange. With a single mouse-click, the program imports all addresses from any existing company mail systems and converts them into MIME format. The software also scans viruses and anything copied to the network. It supports multiple DNS servers and multiple domains.
Price: Call company.
Advox, Täby, Sweden,
+46 8 544 909 00;
fax: +46 8 732 49 72;
info@advox.se;
http://www.advox.se.
Circle 1065 on Inquiry Card.

CAD/CAM

Recycling Costs

BOOTHROYD DEWHURST AND TNO INSTItute of Industrial Technology have codeveloped Design for Environment. Version 1.0 helps engineers analyze the economics and ecology of product recycling. The resulting data reveals the associated cost benefits for various options, such as material recycling, part remanufacture or reuse, and disposal through landfills or incineration. Designers can also pinpoint in the disassembly sequence where major economic and ecological benefits end and where further disassembly is of no benefit either financially or environmentally. The environmental impact of products is determined using a value-assessment metric developed in Europe at TNO.
Price: US$5500 per license.
TNO Institute of Industrial Technology, Delft, The Netherlands, 31 152608909;
fax: +31 152608756;
http://www.tno.nl/instit/indus/dfe.
Circle 1066 on Inquiry Card.



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Internet: http://www.seh.de
E-Mail: info@seh.de
CS-Id.: 100742,1452

SEH Computertechnik GmbH

Circle 751 on Inquiry Card (RESELLERS: 752).

ISA-Station

Slot-Extension for Toshiba-Notebooks of Satellite-Series
(100-, 200- & 400-Series)

With this expansion-unit you can now use the Toshiba-notebooks of the Satellite-Series for all applications that require a 8- or 16-bit PC/AT-size card. It is easily connected with the notebook via the 150-pin expansion bus. It is operated by the built-in power-supply or battery of the notebook. For prices and further information please contact us by fax.

- 1x 8/16-bit ISA full length
- 1x ser. 1x par., VGA, PS/2 mouse and keyboard
- Power-supply via Notebook (internal AC-adapter or battery)
- Operating time on battery: 2–3 hours
- 14 x 8,25 x 2,2", 2,2 kg
- Option: aluminum carrying-case for mobile use

IN PREPARATION

- Internal electronic module for Toshiba notebooks for discharge of NiMH-batteries to prevent loss of capacity by memory effect.
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CeBIT'97 HANNOVER 13.—19.03.1997 Halle 4 Stand G22

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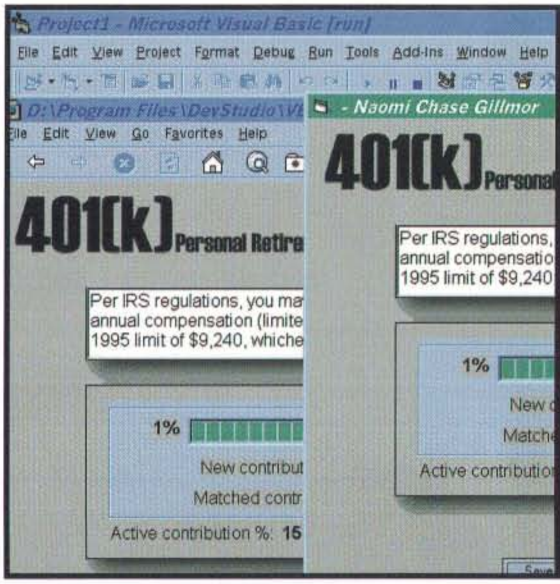
Microsoft's new Visual Basic 5.0, dripping with new features, is redesigned for the Internet. ***By Steve Gillmor***

The Basics of Web Development

Microsoft's Internet strategy continues to come into focus with the version 5 release of its best-selling Visual Basic (VB) programming development tool. VB 5.0 (VB5) draws on innovations from a variety of sources: Microsoft's high-end Visual C++ product, the Office 97 suite, and the growing number of Windows NT and Back Office services.


Project1 - Microsoft Visual Basic [run]
File Edit View Project Format Debug Run Tools Add-Ins Window Help
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401(k) Personal Retire
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VB5's ActiveX Document Migration Wizard converts a standard VB application to a Web-ready Active Document.

Visual Basic 5.0
Price unavailable at press time
Requires 486/66, Windows 95 or NT, a VGA or better monitor, and CD-ROM. Memory and disk requirements vary with the three editions.

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http://www.microsoft.com/vbasic/

Circle 1087 on Inquiry Card.

From Office 97 comes a host of user-interface enhancements, including the IntelliSense technology and the streamlined VB Application Edition integrated development environment (IDE), now used by most of the Office products. Visual C++ contributes its native compiler and the ability to create ActiveX controls, and VB5's Enterprise Edition scales up with bundled client/server tools, Microsoft Transaction Server 1.0, and a developer version of SQL Server 6.5.

Three Flavors

VB5 comes in three editions: Learning, Professional, and Enterprise. The Learning Edition replaces VB4's Standard Edition, adding an interactive CD-ROM tutorial based on Microsoft's Mastering series. You can't create ActiveX controls with this version, but the freeware Control Creation Edition, which is posted on Microsoft's Web site, comes bundled in the box.

All four editions feature VB5's sleek new IDE, but only the Professional and Enterprise versions leverage the new extensibility model, which exposes virtually all the product's capabilities to programmatic control. This pays off immediately in a series of new Wizards and add-ins.

Active Creation

You can create ActiveX controls from scratch, by combining existing controls, or by extending the features of other controls using subclassing. VB5 lets you work on multiple projects simultaneously to test and debug an ActiveX control project within a separate host project.

The new Forms Layout window lets you position your application's forms at design time, adjusting the look and feel at different resolutions. The Properties window adds a new Categorized view that groups properties by type. The Object Browser can now search one or all referenced libraries and then jump you directly to modules and procedures in your projects.

Active Intelligence

VB5's IntelliSense features take advantage of ActiveX's COM technology, which automatically exposes type information, including objects, properties, methods, and statements. The code window bristles with interactive tools: Quick Info displays context-sensitive syntax for statements and functions, List Members provides a drop-down list of properties and methods when you enter a control's name, and Complete Word fleshes out entity names as you type.

Debugging is smarter, too. In break mode, when you position the cursor over a variable, a Data Tip pops up, displaying the value. You can run code at design time and in break mode from the Immediate window, drag a variable from the code window into the Watch window, and set breakpoints and current lines by clicking visual margin indicators.

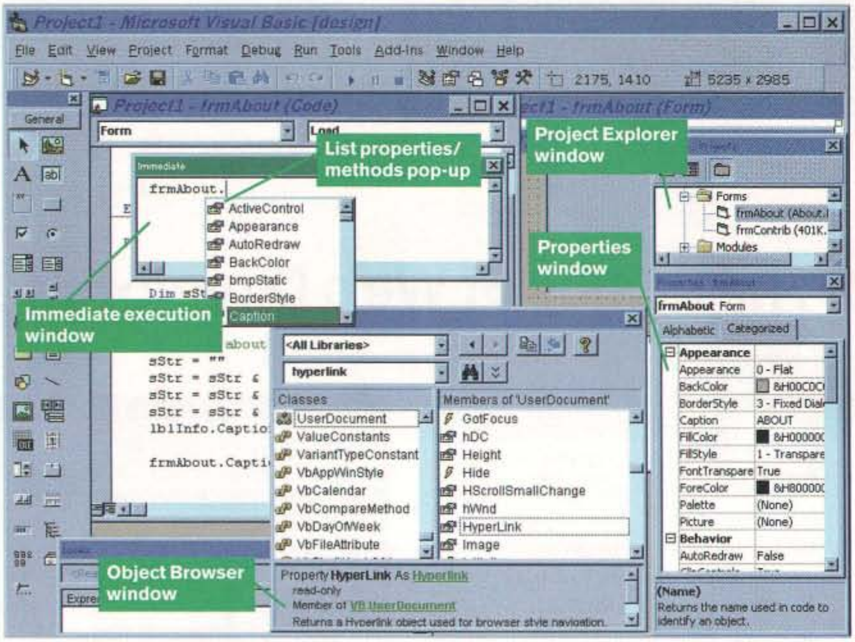
RATINGS	
TECHNOLOGY	★★★★★
IMPLEMENTATION	★★★★★

VB5's language enhancements center on the new ActiveX-creation capabilities. You can raise events in your components and handle events raised by other applications or your own objects. The `Implements` statement supports polymorphism, allowing multiple classes to respond to the same interface.

Rolling your own ActiveX control is not a trivial endeavor, but the ActiveX Control Interface Wizard makes it easier by marrying properties, methods, and events for common controls with your own custom interface. The Property Page Wizard assembles a tabbed properties dialogue that your control's user accesses at design time by right-clicking on the control.

The Professional and Enterprise versions support the creation of Active Documents, a new VB project type that creates applications that can be run in Microsoft's Internet Explorer (see the Tech Focus below). VB4's Setup Wizard has been enhanced to support ActiveX controls and Active Documents, packaging your components into compressed `CAB` files (short for Cabinet files) and generating sample Hypertext Markup Language (HTML) code that points at your control.

You can link to secondary `CAB` files, such as VB5's 700-KB run-time component and other data-access modules, or point at a central location on your intranet. When a browser user clicks on your control or jumps to an Active Document page, the ActiveX code is downloaded to the user's machine, verified for safety, decompressed, registered in the Windows registry, installed, and then activated.


Project1 - Microsoft Visual Basic [design]
List properties/ methods pop-up
Project Explorer window
Properties window
Immediate execution window
Object Browser window

VB5's IDE brims over with explorers, browsers, and pop-ups.

TECH FOCUS

From Form to Active Document

The ActiveX Document Migration Wizard converts existing forms into Active Documents. The Wizard copies selected forms into new user documents and then copies all controls—retaining their names, positions, and properties. The Wizard then converts event handlers to work correctly in the new environment so that `Form_Load` is remapped as `UserDocument_Initialize`. Other invalid code is commented out, and your application Project Type is changed to an ActiveX EXE or DLL. The Wizard leaves you with suggestions for adding appropriate methods, such as the Hyperlink object, to allow navigation in containers such as the Internet Explorer.

Developers can configure Active Document–based projects to function alone or within a browser. You can detect the host environment and then use logic that either loads a form or jumps to a user document. You can also host the Internet Explorer as an ActiveX control to display user documents on the desktop.

True Compilation

With VB5's native-code compiler technology, developers now have the choice of compiling in VB's interpreted pseudocode format or directly in optimized native-code format.

Compiled code delivers up to 20 times the performance of pseudocode; this is particularly noticeable with compute-intensive operations common to three-tier distributed applications. To use the multithreading support, you must use the Unattended Execution option to build components that suppress all message boxes and dialog boxes, letting your program operate unattended on remote computers.

To the Enterprise

The Enterprise Edition tools move well beyond VB4's tentative steps into three-tier development. Microsoft Transaction Server shields VB developers from the complexities of distributed component architectures, handling server registration, process and thread management, resource management and synchronization, and component-based security.

The Visual Database Tools incorporate Microsoft Access's drag-and-drop user interface. The Database Designer for SQL Server 6.5 directly attaches to your prototype database; you can interactively change SQL field data types and let the Database Designer rebuild your database under document description language (DDL) script control. The Query Designer allows you to construct SQL statements with visual and direct editing windows, updating in real-time on one screen.

VB5 provides an integrated Transact SQL Debugger that lets you step through stored procedure code as if it were application code. Other tools streamline data connections, save processing time with batch operations, and perform simulations to profile multitier application performance in different network topologies.

The Last Box

VB5 will prove to be as important to Microsoft's fortunes as it is for programmers'. The ActiveX and Active Documents technologies provide an automated migration path via the Web that can transparently replicate changes to Microsoft Office, Back Office, and Windows tools as you browse the Web. This version may be the last copy of VB that you buy in a box. **B**

Steve Gillmor is a VB consultant for Southern Digital, Inc. (Charleston, SC). He is the author of the forthcoming Lotus Notes Domino Toolkit *(McGraw-Hill). You can reach him by sending e-mail to* **sgillmor@aol.com.**

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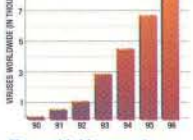

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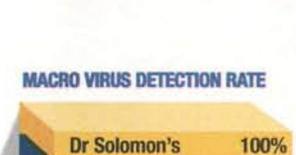
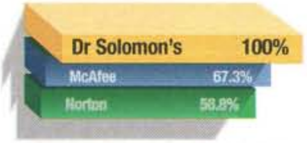


*SOURCE — **Secure Computing, January 1997***

Macro viruses represent the newest threat to your computer today, and they're easily shared via documents and email. No other product detects and removes them like Dr Solomon's.

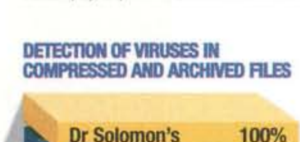
POLYMORPHIC VIRUSES



*SOURCE — **Virus Bulletin, October 1996***

Polymorphic viruses are the most difficult to detect because each infection looks different. Dr Solomon's detects polymorphic viruses better than all the rest.

DETECTION OF VIRUSES IN COMPRESSED AND ARCHIVED FILES



*SOURCE — **Secure Computing, January 1997***

Dr Solomon's is far more advanced in detecting viruses lurking within zipped and compressed files including Internet downloads covering the widest variety of file compression formats.

SYSTEM REQUIREMENTS: • 4 MB RAM (8 MB recommended) • 5 MB available hard disk space • VGA, 16 colors or higher
• Windows compatible mouse • 14.4/28.8 modem recommended • Internet access recommended
• **For Microsoft Windows 95™:** IBM PC or compatible with a 486/25 MHz processor or higher
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NEC's Versa 6200MX is among the first notebooks to show off the new 13.3-inch active-matrix display. ***By Robert L. Hummel***

Notebook with a View

NEC Versa 6200MX
$6399
(estimated street price)
(with a 166-MHz Pentium MMX, 2.1-GB hard drive, 32 MB of RAM, and 10× CD-ROM drive)

NEC Computer Systems
Mountain View, CA

(800) 632-8377
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http://www.nec.com/

Circle 1086 on Inquiry Card.

With its big screen, 166-MHz MMX Pentium, 10× CD-ROM drive, and 3-D sound, the Versa 6200MX is a natural for presentations.

The NEC Versa 6200MX multimedia notebook offers no-compromise potency, whether showcasing a presentation, docked in the office, or serving as your desktop at home. However, its 13.3-inch screen, 166-MHz Pentium multimedia extensions (MMX) processor, and extensive built-in multimedia hardware make it a pricey toy that even power users will struggle to justify at an estimated street price of $6399.

What you notice first is the high-contrast, high-detail 13.3-inch active-matrix screen. Sporting 1024- by 768-pixel resolution and 65,536 colors, the display offers the same viewable area as a 15-inch desktop monitor, only it's much sharper. The display is not without problems, however. Tilting the screen to its optimal viewing angle is also the best way to catch reflection from overhead lights, so you end up adjusting to acceptable but not optimal viewing conditions. With its large screen, the 2.3-inch-high 6200MX also won't fit on an airline tray table in coach.

Portable multimedia presentation appears to be the real market for the 8-pound 6200MX. Its large screen, 10× CD-ROM drive, and built-in 3-D stereo sound make it a natural host for tabletop presentations. Also, the built-in external monitor and NTSC/PAL ports provide easy hookup to TV monitors and projection devices. External speakers are a must, however, because the tinny sound squeezed through the quarter-size built-in speakers doesn't cut it for presentations. That's true with most portables.

NEC quotes Intel's claim that the 166-MHz Pentium MMX increases performance 10 percent to 40 percent over a 150-MHz Pentium—just what you'd expect from the chip's 10 percent faster clock speed, larger 32-KB on-chip L1 cache, and 66-MHz external bus speed. Improvements directly attributable to MMX will remain elusive with current software.

Standard equipment on the 6200MX includes a 2.1-GB hard drive and 32 MB (upgradable to 128 MB) of extended data out (EDO) RAM. A single front-accessible bay accepts a variety of plug-ins; the CD-ROM drive and a 1.44-MB floppy drive are standard. But this 8-pound notebook can't hold both at once. Other optional VersaBay modules include a second 2.1-GB hard drive or a second lithium-ion battery. Two 32-bit PC Card slots provide the ability to add network, video-capture, or modem functions. It supports Zoomed Video, and the optional docking station supports hot docking. Alternatively, the PortBar is a lower-cost alternative that provides a single connection for peripherals only.

A glance at the LCD status panel lets you know how much battery power is left. The display stays visible when you turn off the laptop and it's connected to AC power—a nice feature that lets you monitor charging. NEC claims up to 3 hours of computing with a single-battery system; our real-world tests showed a useful life of about 90 minutes. You can completely recharge the battery in about the same time.

The 6200MX combines power and versatility in a package that is clearly aimed at laptop users who want the highest performance—regardless of cost. If multimedia presentations are part of your job or if you need a single computer for desktop and laptop, the Versa 6200MX is worth a long look. **B**

RATINGS	
TECHNOLOGY	★★★★★
IMPLEMENTATION	★★★★

Robert L. Hummel is an electrical engineer, programmer, and consultant. You can reach him on the Internet at **rhummel@monad.net.**

PHOTOGRAPH: BRIAN WILDER © 1997

Eval

Hand-Held PC

Philips' new Velo 1 uses a unique CPU with DSP power to cut weight and add functionality. ***By Peter Wayner***

This Hand-Held Stands Out

The first group of hand-held PCs (HPCs) to run Windows CE were remarkably similar to one another (see "At Last: Pocket PCs That Run Windows," January BYTE). The greatest differences were not in the electronics but in details, such as the plastic shell and the stylus location. Philips breaks out of this mold with a different and more capable HPC, the Velo 1.

The Velo still runs Windows CE, its most important job, but it uses a CPU with enough floating-point horsepower to run standard digital signal processing (DSP) algorithms. Thus, there's no need for a separate modem; the main CPU also functions as a 19.2-Kbps unit (with a nifty built-in, low-profile RJ-11 connector), saving both power and space. (See the Tech Focus below for more information.)

Velo 1
$599
with 2 MB of RAM; with 4 MB, $699; with 4 MB and rechargeable battery, $739

Philips Mobile
Computing Group
Sunnyvale, CA

(408) 523-2800
fax: (408) 523-7800

http://www.velo1.com

Circle 977
on Inquiry Card.

The Velo 1 packs together the usual Windows CE goodies with up to 104 MB of RAM and a built-in modem and sound recorder.

Additional benefits accrue from this extra power. The Velo 1 offers a built-in voice recorder that can store about 16 minutes of sound per megabyte of available memory, and you can transfer the resulting WAV file to another computer. You start recording quite unobtrusively, by pressing one external button. Sound quality is good for such a small machine, provided you aim the mike (hidden behind a pinhole) in the right direction.

Unlike other HPCs on the market, the Velo 1 doesn't have a built-in PC Card slot. It does have two Miniature Card slots (which are like PC Card slots, but smaller and faster) for future expansion. To use a PC Card device, such as a digital camera, you have to attach the optional V-Module with one slot; it adds about a half-inch to the Velo's thickness.

The space not needed for a PC Card is given over to two bays for RAM chips. The current model comes with up to 4 MB of RAM, expandable in the future to a total of 104 MB...in a palmtop! Of course, power consumption will rise.

We tested a prototype that exhibited a faster-than-expected power drain, but this is being fixed, and production models should run for 12 to 15 hours on two alkaline AA cells, which is comparable to other CE machines.

Philips worked hard on the aesthetics of the Velo 1, and it shows. The hard, oval keys have a good tactile response and plenty of space between them. But the machine's overall small size is still limiting; the keyboard wasn't comfortable enough for me to write this review on the Velo.

RATINGS	
TECHNOLOGY	★★★★★
IMPLEMENTATION	★★★★★
PERFORMANCE	★★★★

But for many purposes, the Velo 1 is a nice system. We expect that users will be drawn to the attractive packaging and the built-in modem and sound recorder, which set it apart from the rest. **B**

Peter Wayner is a BYTE consulting editor based in Baltimore. You can contact him at **pcw@access.digex.net.**

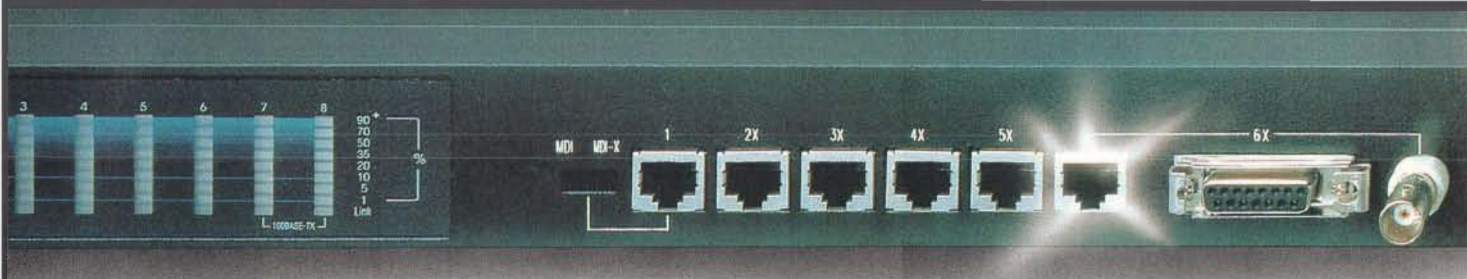
TECH FOCUS

New Chips on the Block

The Velo 1 uses Philips' own PR31500 and UCB1100, a pair of CPU chips that provide excellent computing power at low cost. The PR31500 is a 40-MHz, 3.3-V version of the Mips R3000 RISC chip with an additional DSP unit for doing computations common in telecommunications. This allows it to run the main machine as well as act as a modem or audio recorder. The UCB1100 contains the codec for telephone-line interfacing, and it can be turned off when not in use. The PR31500 also contains the first type of code compression offered by Mips that can save memory. No NOPs are needed, because the pipeline can stall until information from a load or branch is available.

PHOTOGRAPH: BRIAN WILDER © 1997

★★★★★ Outstanding ★★★★ Very Good ★★★ Good ★★ Fair ★ Poor



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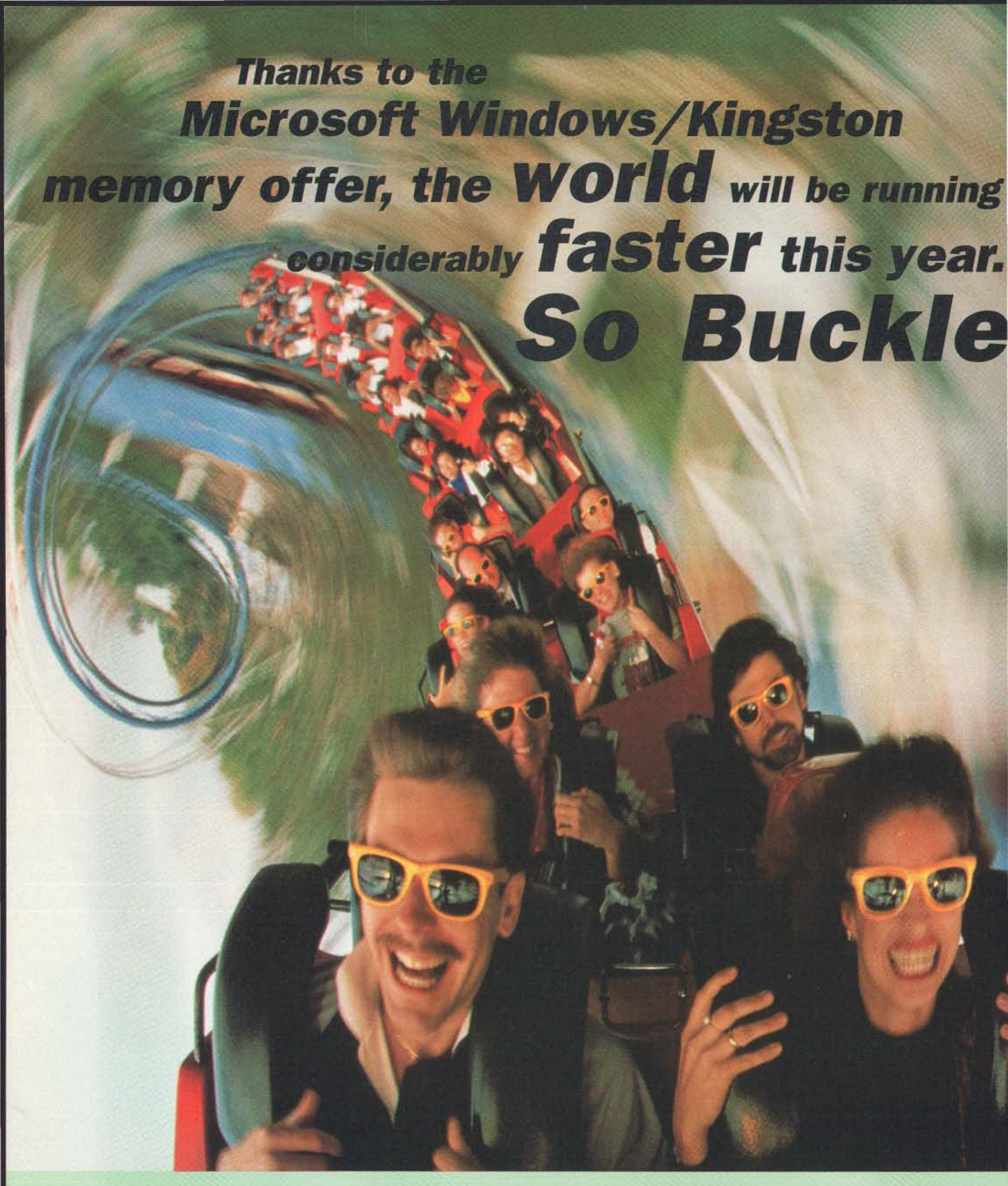
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So Buckle

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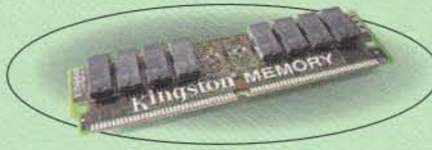

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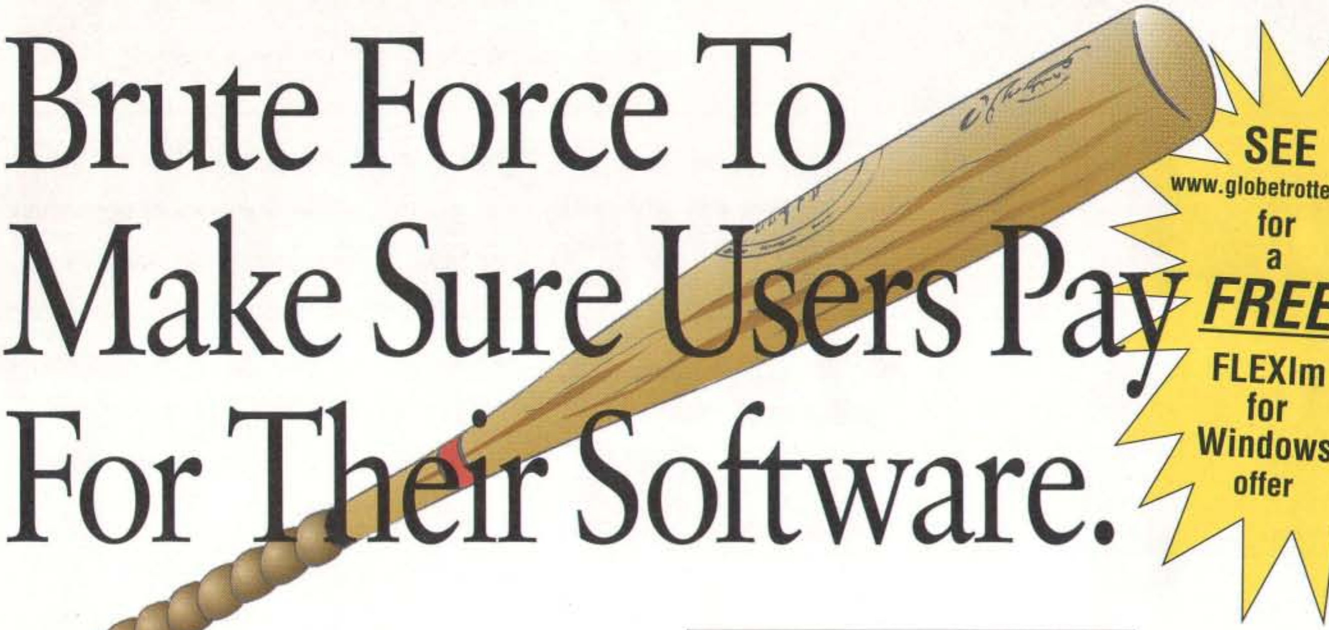

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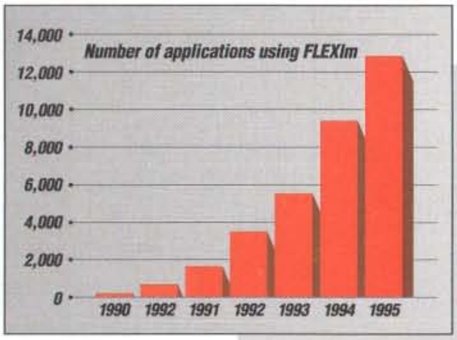

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Circle 167 on Inquiry Card.

Long-awaited adaptive technology comes to the Unix platform. ***By Joseph J. Lazzaro***

Unix Helps the Disabled

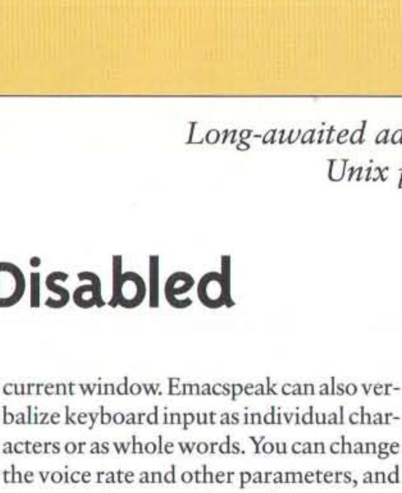
If you're a computer user with a disability, you're out of luck if the adaptive software you need to manage your world won't run on the operating system of your choice. This problem can stand in the way of your ability to take a college course, land a promotion, or maybe even get a job in the first place. While Unix is one of the most senior operating systems, ironically it is the one most lacking in technology to assist people with disabilities. Fortunately, the good news is that the list of adaptive hardware and software for Unix is beginning to grow. In this article, I'll explore several Unix-based adaptive programs to assist users with disabilities. As you might expect, most of these programs are being developed by the Unix community itself, and many of them are now available free of charge on the Internet.

Talk to Me

Speech output offers help for computer users with vision impairments. A module called Emacspeak makes the standard Emacs editor talk; it can speak individual characters, words, lines, or the whole screen. The program allows users with vision impairments to create and edit files with speech feedback, run other programs, and verbalize their output, as long as they have a hardware voice synthesizer. Emacspeak works with the standard text user interface, not under the X Window graphical user interface. While within Emacspeak, you can run third-party programs using speech confirmation.

Emacspeak is highly customizable and can provide verbal feedback to suit your needs. For example, the program can notify you if the current line is indented by issuing an audible tone. You can also instruct Emacspeak to read the current sentence, column, or the contents of the current window. Emacspeak can also verbalize keyboard input as individual characters or as whole words. You can change the voice rate and other parameters, and you can choose to have the program speak all, some, or no punctuation.

Emacspeak currently supports the DECtalk Express speech synthesizer from Digital Equipment Corporation. The DECtalk Express is a portable, battery-powered synthesizer that has an unlimited vocabulary. The device attaches to the computer through the serial port, comes with nine natural-sounding voices, and is the speech box of choice in the adaptive computing industry.



90 Commands Loaded

- _MICROPHONE
- Again
- audiotool
- Autocad
- bigger
- bob shell
- bolder
- Bullets
- calculator
- calendar
- cancel
- center

V2.2 Copyright 1992–94, Command Corp. Inc.

Status: Recognition is active

In Cube lets a voice command trigger mouse and keystroke actions.

Reading the Screen

Screen readers are software programs that intercept information written to the video monitor and route it to a voice synthesizer. They can also drive braille displays to provide braille output. Screen readers and speech synthesizers let people with vision problems run commercial Unix software and browse the Internet. These programs have hot keys for reading characters, words, lines, windows, and any portion of the display. Although there have been numerous screen readers for DOS, Macintosh, Windows, and OS/2, there have been no native Unix screen readers—until now.

UltraSonix is the first native screen reader for X Window systems. Developed at the Georgia Institute of Technology under a federal grant and recently released into the public domain, UltraSonix was known as Mercator while it was a research project. Georgia Tech is no longer developing UltraSonix, but the authors wanted assurance the code would be available to those who need it most: visually impaired people using the X Window interface. The source code of UltraSonix is free for noncommercial use. According to the developers, the UltraSonix source code will compile and run on Sun SparcStations running Solaris 2.5 and the Common Desktop Environment (CDE).

The Trace Research & Development Center is coordinating the ongoing work of porting UltraSonix to Linux. You can get the source code via anonymous FTP at ftp://multimedia.cc.gatech.edu/pub/UltraSonix.source-7.0.tar.Z. This file includes the complete source code for the core system. For more information on UltraSonix, visit Brian Sellden's Web sites at http://henge.com/~brian or http://henge1.henge.com/~brian/ultralin.html. For commercial use, you should contact the Office of Technology Licensing at Georgia Tech.

Another program worth checking out is Puff. It is X Window-based screen-magnification software intended for people who can't read text at the size it's usually displayed. Puff automatically tracks and follows the mouse pointer, magnifying the portion of the screen around the cursor. The program can magnify both text and graphics. You can obtain Puff, a 33-KB program, from the Trace Center software library at ftp://trace.wisc.edu/pub/access_utils/unix/puff.tar.gz.

Unix at Your Fingertips

PowerBraille is a refreshable braille display manufactured by Telesensory, Inc. The PowerBraille device connects to the computer, and mechanical braille dots come to life one screen line at a time. PowerBraille is available in models that generate three basic character sizes: 40, 65, and 80 cells, where a cell is a braille character of eight dots. With an 80-cell display, the company says, you can "read spreadsheets and most columnar text"; in other words, you can read an 80-character text display. The unit has both a serial and a parallel interface, and it works with DOS and Windows platforms as well. PowerBraille tracks either the mouse or the standard cursor, allowing you to read anything on the video monitor. PowerBraille can be driven by a number of platform-specific screen readers and software programs.

Screen is a simple screen-reader program that allows blind users to directly connect the PowerBraille to a Unix box. The program, developed at Oregon State University, allows the braille terminal to view several different processes, typically interactive Unix shells. Screen allows the user to directly view each session on the braille display. Screen runs under SPARC, HP300, and HP800.

BRLLTY is another basic screen-reader program that works with the PowerBraille display. This software allows access to the console of a Unix system running Linux (kernel version 1.1.92 or later) on a PC or a DEC Alpha machine. BRLLTY allows the user to read characters, words, lines, or the whole screen. Both the Screen and BRLLTY programs can be located at the Telesensory home page at http://www.telesensory.com.

For persons having difficulty entering text at the keyboard, voice recognition might do the job. In Cube is a continuous-voice-recognition software package for SPARC workstations running Sun OS 4.1.x and Solaris 2.x. In Cube lets you issue verbal commands to your audio-capable SparcStation using a microphone. You can construct sets of verbal commands for each application on your system. In Cube can automatically load each verbal command set when an application assumes focus. The package also provides a lexicon editor for creating and editing voice commands. In Cube includes tools for navigating windows and X clients by name, a command mode for launching applications, and an entry window for importing boilerplate text under voice command.

Committee Takes Action

The Trace Research & Development Center at the University of Wisconsin-Madison is a cutting-edge assistive technology lab. (You can find the Trace Center at http://trace.wisc.edu or send e-mail to info@trace.wisc.edu.) Guided by its forward-looking director, Dr. Gregg Vanderheiden, the Trace Center has played a major role in making computers more accessible. Trace drove the effort to make DOS, Windows, Windows 95, and Mac OS more accessible with its Access Pack drivers that were ported to each platform. An all-volunteer group known as the Disability Action Committee for X (DACX), chaired by the Trace Center, has been working behind the scenes since the fall of 1992 to both raise the accessibility awareness in the Unix community and assist in the development of access solutions for Unix. Paralleling their efforts on PC and Macintosh computers, DACX members were able to develop a set of utilities to make Unix more accessible. This first package, known as AccessX, has been available as part of Sun's Solaris 2.4, Digital Unix 3.0, and OpenVMS 6.0. The access features provided by AccessX have since been incorporated into XKB, a standard extension for X11R6.1. XKB includes features to hold and lock modifier keys (for example, Shift, Alt, Ctrl), prevent accidental keystrokes, filter out repeating keys, and assist with operating the mouse. It's very helpful for individuals who have difficulty with the standard input devices.

The Unix community has set its sights on making Unix more accessible to the disability community. This follows a trend in the computer industry as a whole to make OSes more accessible to everyone. Witness Microsoft's unprecedented effort to improve Windows 95 in this respect. As awareness of adaptive technology and its importance increases, we can look forward to expanded access to Unix and other operating systems. **B**

Joseph J. Lazzaro is the author of Adapting PCs for Disabilities *(Addison-Wesley, 1996). He is also project director of the Adaptive Technology Program at the Massachusetts Commission for the Blind, based in Boston. You can reach him at* **lazzaro@world.std.com**.

Access to Linux

There is an effort to make Linux more accessible to people who are blind or visually impaired. Since it's an inexpensive operating system, Linux makes good sense for users on a modest budget. An ongoing project, called BLinux, will enable visually impaired users to install and run Linux on their systems. To simplify this process, installation-specific HOWTO documentation files are printed in braille and recorded on audio tape, so a blind user can install Linux without having a second computer to read the on-line documents. Once Linux is running, the user can take advantage of the extensive on-line HOWTO files that are in formats that can be handled by speech software and screen readers.

The people behind BLinux will continue to add adaptive features previously unavailable under Unix. Some of the new features will include support for braille and speech, a Web browsing facility, and more. The BLinux Web site—http://leb.net/blinux/—is well worth a visit. You can find the source code on the archive site at ftp://leb.net/pub/blinux.

WHERE TO FIND

Telesensory
(PowerBraille)
Mountain View, CA
(415) 960-0920
fax: (415) 960-0462
info@telesensory.com
http://www.telesensory.com

Digital Equipment Corp.
(DECtalk Express Speech Synthesizer)
Nashua, NH
(800) 722-9332
fax: (603) 884-5597

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Circle 157 on Inquiry Card.

A fault-tolerance mechanism paves a safe migration path to ATM for mission-critical applications. ***By Steen B. Lohse***

Reliable ATM Networking

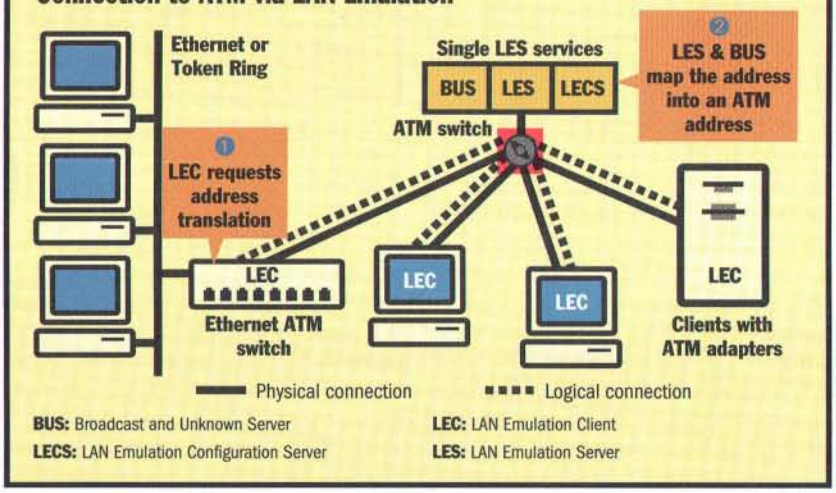
As today's IT infrastructure continues to swell in both size and complexity, companies are looking at moving to asynchronous transfer mode (ATM) technology. It offers bandwidth of up to 155 Mbps (and now 622 Mbps between switches) on the backbone and delivery pipes of 25 Mbps or more to the desktop. At the same time, a network manager must preserve the company's investment in legacy networks, while still supporting the installed base of network applications. For example, LAN-based applications such as Lotus Notes, Windows NT Advanced Server, and NetWare, which currently do not run natively on ATM, require a route to the ATM segment.

LAN emulation (LANE) over ATM is the natural path for migrating Token Ring and Ethernet LANs to fault-tolerant ATM networks. The ATM Forum's LANE specification 1.0 addresses the issue of building a robust network composed of legacy LAN servers and ATM segments. However, the LANE specification presents a potentially fatal flaw for network managers: Version 1.0 permits only one LANE Server (LES) and Broadcast and Unknown Server (BUS) on an emulated network, creating the possibility of a much-dreaded single point of failure.

Life in the Fast LANE

LANE defines how an Ethernet- or Token Ring-based network OS and applications run unmodified over an ATM network. LANE works by allowing the OS and all protocols at and above Layer 2 to seamlessly operate with ATM. An ATM adapter that uses LANE drivers—based on Network Driver Interface Specification (NDIS) or Open Data-Link Interface (ODI)—appears to the server's protocol stack and NOS as an Ethernet or a Token Ring adapter. Address conversions are facilitated by implementing a client/server architecture whereby the media access control (MAC) addresses (Layer 2) are mapped to ATM addresses for all emulated end stations. Thus, existing LAN applications can be used on ATM networks without changing the underlying protocols.

Connection to ATM via LAN Emulation


Ethernet or Token Ring
Single LES services
BUS
LES
LECS
❷ LES & BUS map the address into an ATM address
ATM switch
❶ LEC requests address translation
LEC
Ethernet ATM switch
LEC
LEC
LEC
Clients with ATM adapters
Physical connection
Logical connection
BUS: Broadcast and Unknown Server
LECS: LAN Emulation Configuration Server
LEC: LAN Emulation Client
LES: LAN Emulation Server

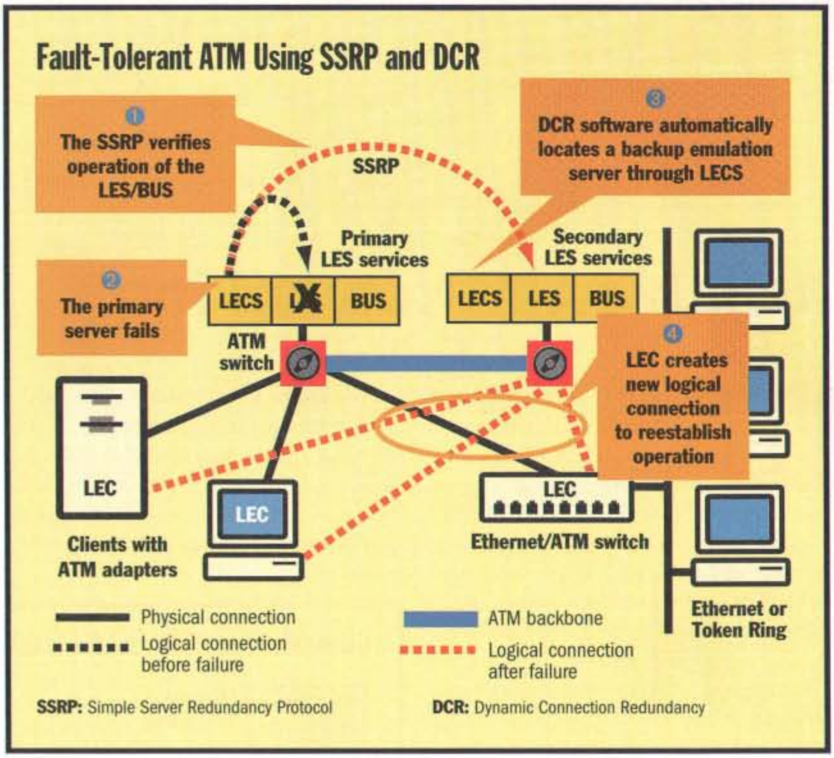
LAN emulation (LANE) maps Ethernet or Token Ring addresses to ATM addresses.

LANE consists of four software components. The first three, all servers, are collectively known as LAN emulation services. Typically residing on ATM switches or edge devices (such as Ethernet or Token Ring switches with ATM uplinks), these services perform tasks such as indicating what type of LAN is being emulated; maintaining a table of all LANE end stations; and handling broadcasts, such as NetWare RIP and SAP messages and NetBIOS name queries. Individually, each performs a separate logical function.

The LANE Configuration Server (LECS) contains the configuration of the emulated networks. Typically it resides in a switch or a router and provides configuration information to clients, including the ATM address of the LANE Server. This server is responsible for dynamically assigning LANE clients (LECs) to the different emulated LANs they desire, regardless of the physical switch port used.

The LES acts as a central clearinghouse for mapping between MAC addresses and ATM addresses. It can be configured as a dedicated station, integrated into a switch or edge device, or provided as software for a PC or workstation. It is typically implemented in the same device as the Broadcast and Unknown Server, discussed next. As noted, it also is the weak link in LANE because it's a potential single point of failure.

The BUS handles broadcast and multicast frames, as well as frames for which the destination unicast MAC address has not yet been resolved to an ATM address. It is a vital component because it resolves the inherent differences between traditional broadcast-based LANs, such as


Fault-Tolerant ATM Using SSRP and DCR
①
The SSRP verifies operation of the LES/BUS
SSRP
②
The primary server fails
Primary LES services
LECS
LES
BUS
ATM switch
③
DCR software automatically locates a backup emulation server through LECS
Secondary LES services
LECS
LES
BUS
④
LEC creates new logical connection to reestablish operation
LEC
LEC
Clients with ATM adapters
LEC
Ethernet/ATM switch
Ethernet or Token Ring
Physical connection
Logical connection before failure
ATM backbone
Logical connection after failure
SSRP: Simple Server Redundancy Protocol
DCR: Dynamic Connection Redundancy

Simple Server Redundancy Protocol and Dynamic Connection Redundancy reestablish logical links to devices on the ATM segment.

Token Ring and Ethernet, and the connection-oriented ATM network.

The fourth component, the LANE client, runs on every end station on the emulated LAN. Its main role is to initiate communications with the LECS and the LES and establish connections to other LECs. This includes requesting the LES to map MAC addresses to ATM addresses. Through the connections that are established, the LEC forwards data to the BUS and onto the target LEC. An LEC can be a workstation, file server, bridge, switch, or router. Each LEC has an ATM address and at least one MAC address.

Adding Fault Tolerance

Under version 1.0 of the LANE spec, hardware redundancy isn't possible on the emulated LAN. If the LES or the BUS fails, or is isolated from the network for any reason, then users cannot connect to the ATM backbone.

To address this single-point-of-failure problem, a number of independent vendors have sought to implement solutions that provide fault tolerance on an ATM network. For example, Cisco Systems recently announced its Simple Server Redundancy Protocol (SSRP) that replicates the configuration information in the LANE Servers. SSRP adheres to the specs of the ATM Forum when communicating with the LEC, yet it eliminates the limitation of a single LECS or LES/BUS per emulated LAN. SSRP conveys information between the LECS and the LES/BUS devices as to which are operational and which are not. Basic configuration information about all emulated LANs is shared between the primary and up to three backup LECS devices.

If the LES/BUS fails, connections to the attached LECs are dropped. The client, sensing a network failure, attempts to reconnect to the emulated LAN. It will be directed by the LECS to a functioning backup LES/BUS on another network device. SSRP addresses the critical issue of ATM resilience by providing a software backup, enabling LANE clients to remain fully connected to the network.

SSRP, however, provides only part of the solution toward fault-tolerant LANE over ATM. The network may have a new fully functional LES, but if a workstation is unable to discover this new location, the SSRP enhancement doesn't help. A second vendor, Olicom (for whom this author works), has completed a fault-tolerant solution on the LEC side that builds on SSRP and works within the ATM Forum 1.0 specification. This software (Dynamic Connection Redundancy, or DCR) enables a client to automatically search the ATM network for the location of the new LES/BUS through the LECS.

Working in tandem with SSRP, DCR does this by reading network configuration information via the Interim Local Management Interface (ILMI) from its ATM switch. The ILMI specification is an ATM Forum link management interface that enables two adjacent ATM devices to automatically configure the operating parameters of the common ATM link between them. This process, called *LECS discovery via ILMI*, lets the LANE client locate the new LECS with no need for manual reconfiguration. The usual alternative method—the "well-known address," where the LECS is located at a fixed address—is limited because it does not normally provide for hot standby of these critical services and potentially results in far greater downtime for the ATM LANE network. While SSRP still provides for connection to a backup LECS even when the well-known address is used, DCR provides faster autoreconfiguration and recovery from a network failure. When this occurs, DCR performs a search and establishes a connection to the backup server automatically.

Hard Choices

For network managers who have shied away from ATM because of concerns about adding a nonredundant component to their otherwise fully fault-tolerant network, SSRP and DCR represent an early response to the problem of the single LES/BUS. Managers can deploy ATM with the confidence that they are covered by true, end-to-end fault tolerance. SSRP and DCR work within industry standards to provide for redundant LAN emulation services components, and they eliminate the single point of failure in existing LANE implementations. Although the ATM Forum Technical Working Group expects resolution of the single LES/BUS problem in version 2.0, for a network manager, six to 12 months is a long time to wait. **B**

Steen B. Lohse (**slo@olicom.com**) *is vice president of marketing at Olicom. He holds degrees in engineering and business administration from the University of Copenhagen.*

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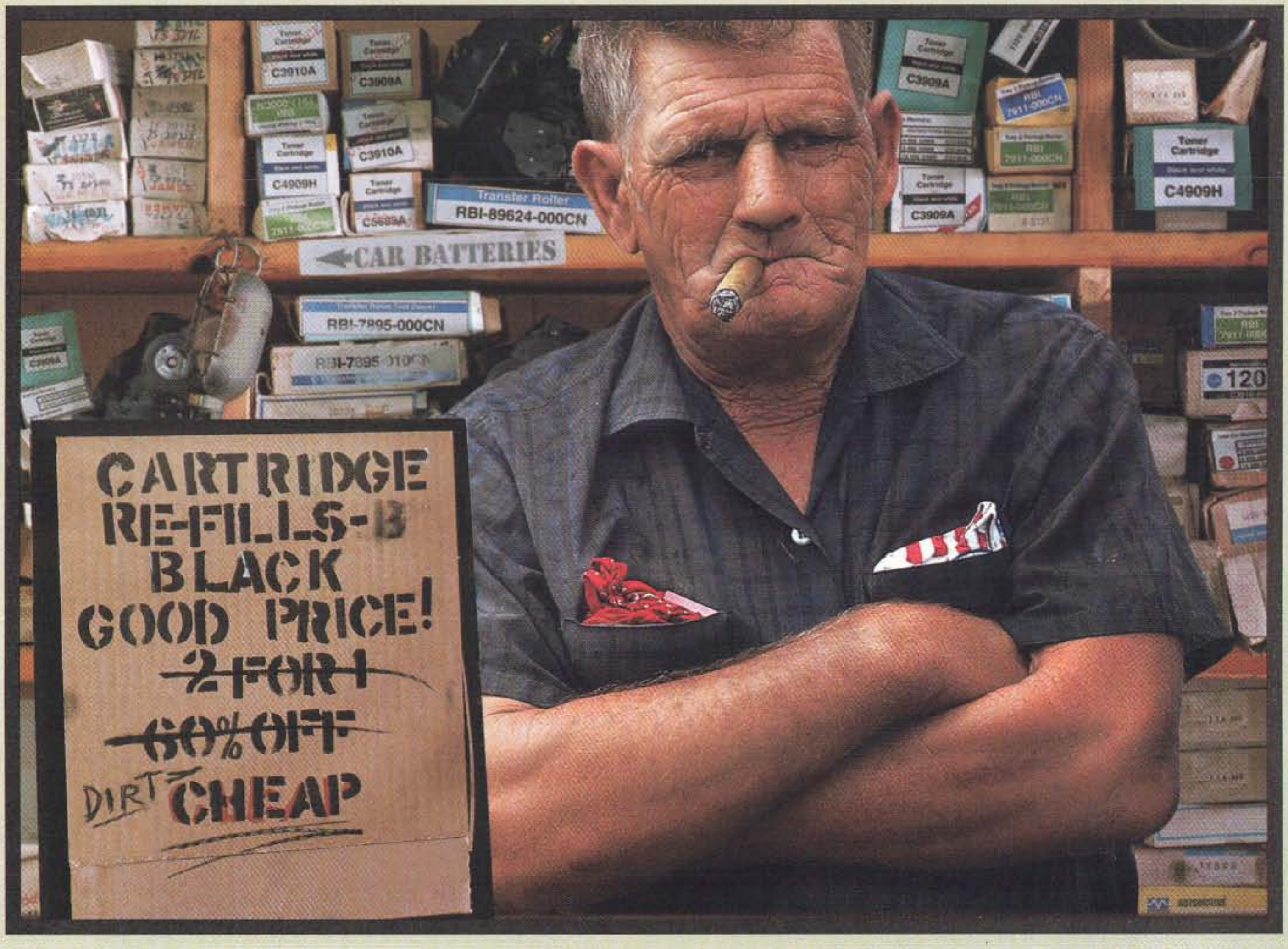

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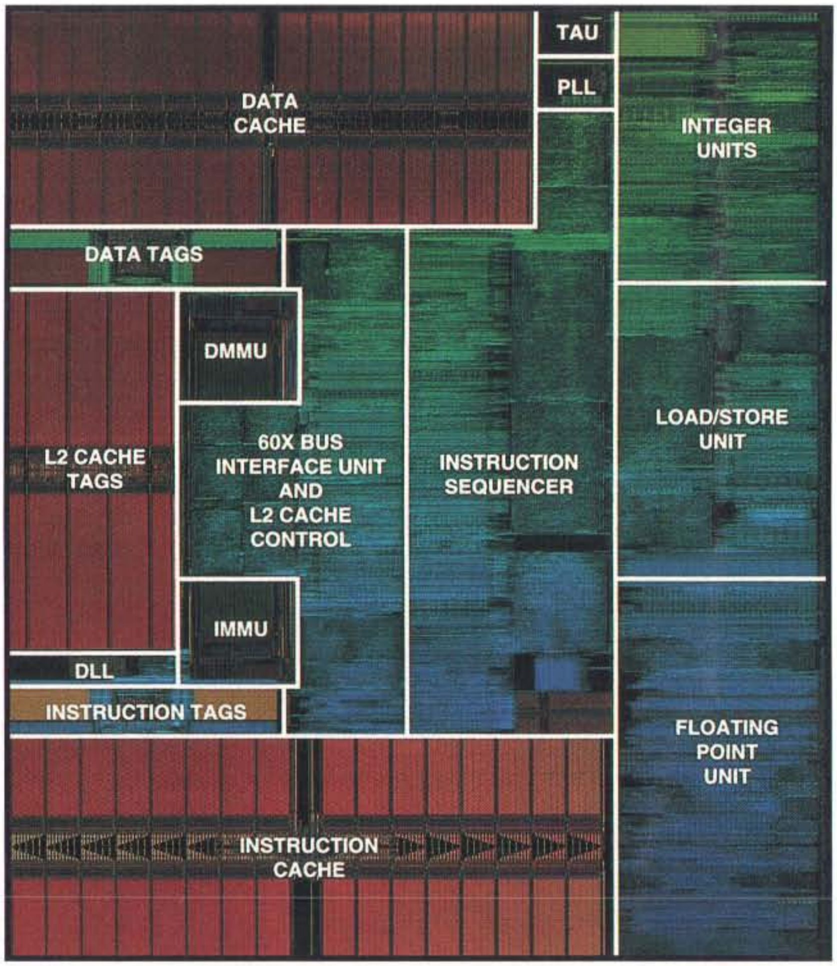
This next-generation PowerPC targets high-performance mobile applications and desktop systems. ***By Tom Thompson***

First Look at PowerPC G3

The alliance of Apple, IBM, and Motorola (AIM) continues to refine and improve its flagship RISC processor, the PowerPC. Certain of these future processor designs are code-named G3 and G4, for third- and fourth-generation. (The PowerPC 601 was considered a first-generation "bridge" processor that contained elements of both IBM's POWER architecture and Motorola's 88110 RISC processor. The 603, 603e, 604, and 604e are second-generation designs based entirely on the PowerPC architecture.) G3 and G4 would be PowerPC instruction-compliant while boosting performance using new features such as L2 cache support or a new bus architecture. In February, IBM and Motorola disclosed the first G3 processor. It's important to note that this chip (still officially unnamed) is the first offering in a series of such third-generation designs. Systems based on the G3 should be available by the middle of the year.

Old and New

The G3, as disclosed, differs somewhat from the PowerPC road map released by IBM and Motorola late last year. In that plan, the G3 would use a 0.35-micron process technology, operate at an initial clock speed of 200 MHz, and certain variations of the design would have nearly 30 million transistors. The announced G3 is a 32-bit processor that leapfrogs the plan and starts at 250 MHz. It uses a 0.25-micron five-metal-layer static CMOS process. This process allows the G3 to pack 6.35 million transistors (the 604e has 5.6 million) onto a die 67 mm^2, making it smaller than the 603e's 81-mm^2 die. This is certainly not one of the 30-million-transistor behemoths alluded to by the AIM alliance, but the specifications are still impressive.

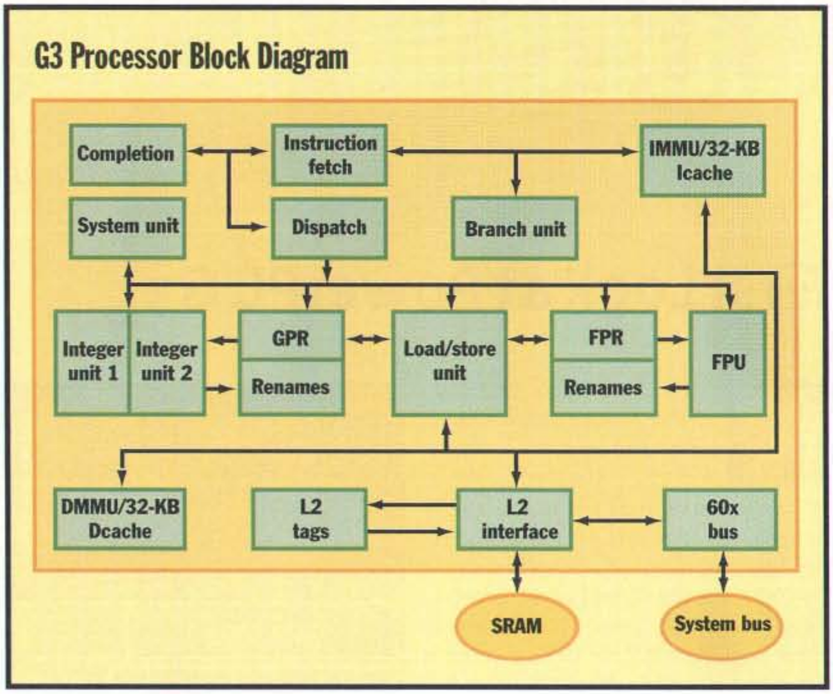


The G3 packs more transistors than a PowerPC 604e on a die that's smaller than a PowerPC 603e.

In designing the G3, the Somerset engineers first did extensive code traces of PowerPC applications. Monitoring the streams of instructions and data this way allowed them to identify bottlenecks in the second-generation PowerPC designs that could be eliminated from the G3. As a result of this approach, the G3 benefits from the best technologies found in the existing 6xx product line. The G3 is an amalgam of the enhanced versions of the 603e's power management, the 604e's dynamic branch prediction logic, and the 620's integrated L2 controller and dedicated cache interface.

As shown in the figure on page 60, the G3's RISC core with five execution units resembles the 603e's. Both designs have a floating-point unit, a branch unit, and a load/store unit. Where they differ is that the G3 has two single-cycle integer units, while the 603e has only one integer unit and a system unit that was counted as an execution unit. The G3's newly designed load/store unit can process loads and stores to the cache in one clock cycle. The FPU has a three-stage pipeline to boost math computations. As mentioned, the G3's branch unit has been beefed up with the 604e's dynamic prediction logic. It can process one branch instruction per cycle, with one speculative stream in execution and an additional speculative stream in fetch.

The G3 uses a four-stage pipeline that consists of fetch, decode-dispatch, execute, and complete-writeback stages. The fetch unit retrieves four instructions per clock. When an instruction gets loaded into the cache, a predecode operation creates a completely new 36-bit opcode. This data assists the processor's dispatch logic in issuing instructions to the proper execution units. The G3 performs only a two-instruction dispatch (like the 603e) because using the 604e's four-instruction dispatch mechanism while maintaining a high clock speed would require a complete redesign. The G3 can, however, sustain a peak execution rate of three instructions per clock.



The G3 uses enhanced technologies of existing PowerPC processors to deliver high performance while consuming little power.

Cache Considerations

The G3 has the same amount of on-chip cache as the 604e: two 32-KB caches (one for instructions, one for data), each supported by its own memory management unit. The caches are eight-way set associative, using 128 sets. The cache size and set count were fixed by the requirement that the G3 be pin-compatible with the 603e and the 604e; one variant of this first G3 uses the same 255-pin ball grid array (BGA) connector. A high-performance variant provides on-chip support for an L2 cache. The built-in L2 cache controller has 4 KB of tag entries that can be configured to manage a two-way set-associative L2 cache set for sizes of 256 KB, 512 KB, or 1 MB. The L2 interface supports direct connections to several types of SRAM. A divider circuit runs the L2 cache memory at ratios of 1:1 to 1:3 in half-clock increments. Of course, the L2 interface requires extra signal pins, and so this G3 variant uses a 360-pin BGA. Both the on-chip and the L2 cache logic support copyback and write-through modes with bus snooping.

Power and Performance

The G3's purpose is to provide high-performance computing power for both mobile applications and desktop systems. The direct L2 cache interface helps meet the performance goals of desktops. For mobile systems, the G3 relies on a proven set of power conservation features lifted from the 603e. The G3 uses a 2.5-V core to reduce power consumption, while the bus interface still operates at 3.3 V for compatibility with existing designs. At 250 MHz, the G3 dissipates 5 W when running at full bore. This is slightly more than a 166-MHz 603e, which dissipates 3 W at peak speed.

The G3 provides a variety of clock multipliers, starting at 2:1 and climbing to 8:1, with half-clock frequency multiples. This allows a desktop design to use, say, a lower-cost 50-MHz system bus while the processor races at 250 MHz. Conversely, portable designs can employ a different multiplier so that the G3 runs at 250 MHz while using a low-power, slower system bus. The dynamic power management hardware monitors the instruction stream and selectively disables the clock to an execution unit that falls idle. A thermal assist unit has an on-die thermometer that allows an OS to monitor the processor's temperature and take action before it overheats. The OS can either switch the G3 into one of the low-power doze, nap, or sleep modes or throttle the instruction cache so that the processor effectively slows down. Once the chip's temperature falls to a preset level, the OS has the G3 resume normal operation.

Motorola and IBM peg the G3's performance—when running at 250 MHz and using a half-speed 1-MB L2 cache and a 50-MHz system bus—at an estimated 10 SPECint95. The G3 thus delivers roughly the same throughput as a 604e but consumes substantially less power (a 166-MHz 604e dissipates 10 W). Therefore, the G3 straddles the capabilities of 603e- and 604e-based designs. The 603e will continue to be used in low-end, low-cost designs. Because the G3's bus implements only the MEI (modified, exclusive, invalid) protocol, like the 603e, it can be used only in single- or dual-processor designs. It will handle high-performance mobile systems or desktop systems. Ultra-high-performance multiprocessor systems will continue to use the 604e. The G3 has been sampling for several months, and because it's pin-compatible with both the 603e and the 604e, you can expect to see it in shipping PowerPC-based computers this summer. ■

Tom Thompson is a BYTE senior technical editor at large. You can contact him via e-mail at **tom_thompson@bix.com.**

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This language can integrate recalcitrant Unix programs and has powerful pattern/action statements. ***By Bob Friesenhahn***

Expect Offers Unix Scripting

One of Unix's greatest strengths is its large collection of tools and utilities that you can join via the Unix shell to create powerful programs. Put another way, these tools and utilities are well designed to be used by other programs. However, in some cases, due to accident or the nature of the application, some programs don't support the simple utility model. Typical programs that break the model are common ones (e.g., FTP, telnet, and the passwd utility). Programmers have been stymied trying to smoothly integrate these wayward utilities into larger applications—at least until now.

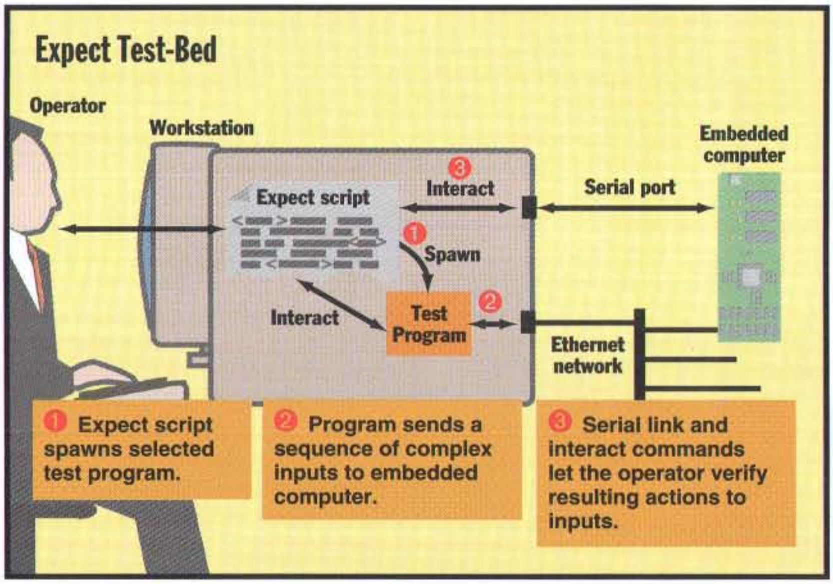
Expect, an extension of the simple yet powerful Tool Command Language (Tcl), is a latecomer to the Unix toolkit. It's an extensible interactive language whose scripting facilities surpass even those the best terminal programs offer. Expect has the unique capability of "chatting" to otherwise impossible programs and can smoothly juggle input and output to many places at once. The interactive facilities Expect offers open new dimensions of opportunity in automation, capability, and testing. Don Libes wrote Expect at the National Institute of Standards and Technology (NIST) in 1987. Given the new programming paradigms offered by Expect, we can assume that it will evolve for many more years.

Tcl

Before I get into the details of Expect, I need to say a bit about Tcl, the language it is based on. Tcl entered the world of Expect in 1991 and has shaped its evolution ever since. It was released by John Ousterhout at California-Berkeley in 1989. Tcl's purpose is to be an embeddable interpreted language that other programs can use as an extension language. While many programs use Tcl as an embedded language, the most popular application of Tcl's extensibility has been to add new commands to its sample shell (i.e., interpreter) to enhance its scripting capability.

It is easy to add new commands to a Tcl interpreter because of the trivial interface required (similar to the main routine in a C program). Furthermore, new commands are normally added as a set of related functions that form a package. These packages usually add a major capability to Tcl, and Expect itself is a package of commands. Other packages are Tk (GUI), TclX (expanded Unix command set), dp (Internet/Unix sockets and remote procedure call [RPC]), and [incr Tcl] (object-oriented language extensions).

The developer is free to mix and match these extensions. Often, they load only on demand and provide the ideal mix of features required for a given application. With these extensions, it is easy—compared to compiled languages—to produce powerful, object-oriented, graphical applications that interface with other programs across a network.


Expect Test-Bed

① Expect script spawns selected test program.

② Program sends a sequence of complex inputs to embedded computer.

③ Serial link and interact commands let the operator verify resulting actions to inputs.

You can use Expect to set up and operate programs that test equipment.

Expect Basics

Expect is a tty-oriented language. A tty (in Unix-speak) is an interface with the characteristics of a serial port attached to a character-only terminal. Even after 25 years—and in the presence of GUIs—most Unix programs are still character-oriented and have simple streaming stdin/stdout-type interfaces.

While programs that use this default I/O model are easy to interface with, programs that connect directly to the user's terminal device (tty) don't interface as well. Expect works around this problem by using a pseudoterminal (which is often known as a pty) when it communicates with other programs.

continued

Expect uses a command called `spawn` to associate its equivalent of a file descriptor (known as a spawn ID) to a device or process. By default, Expect assumes that `spawn`'s arguments represent commands to create a new process. However, a flag tells `spawn` to treat the argument as a Tcl file descriptor (obtained via the Tcl `open` command).

This allows associating a spawn ID with a file or a serial device. The action of using `spawn` to create a new spawn ID sets the Tcl global variable `spawn_id` to the numeric value that represents that spawn ID. Expect commands that require a spawn ID use the value of the global `spawn_id` variable if one is not supplied as an argument.

This makes modest tasks trivial to write, because commands don't require an extra argument to specify a process. For complex tasks (e.g., talking to multiple programs at once), it is best to save the value of `spawn_id` to new variables so that you can use them later to specify a process.

The namesake of Expect is the `expect` command that supports pattern/action statements. `Expect` statements can range from simple one-liners to complex statements supporting multiple inputs. The `expect` command would not be useful without the `send` command, which provides the capability to send a message to a spawn ID.

Expect statements take the form:

```
expect [[-opts] pat1 body1] ...
[-opts] patn [bodyn]
```

which simply means that an `expect` statement can support multiple match patterns with associated lines of script. The following example shows the relationship between `expect` and `send`:

```
expect { "How are you doing?" {
send "Great!" } "What is today's
date?" { send [date] } }
```

This script responds with "Great!" when "How are you doing?" is received and returns the current date (via the Tcl `date` command) when "What is today's date?" is received.

In the real world, things often go wrong. You want to detect when a source of input goes away for some reason, or you do not receive a required input in a certain period of time. Expect makes the special patterns `eof` and `timeout` (adjusted by the global `timeout` variable) available to test for these conditions. The programmer also has the special pattern `default` available, which covers both these cases.

Expect Resources

To learn more about Expect and Tcl, you should read the books *Exploring Expect: A Tcl-Based Toolkit for Automating Interactive Programs* by Don Libes (O'Reilly & Associates, ISBN 1-56592-090-2) and *TCL and the Tk Toolkit* by John Ousterhout (Addison-Wesley, ISBN 0-201-63337-X). You can also consult the Expect home page at http://expect.nist.gov/ and the Tcl/Tk Info page at http://www.tcltk.com/. You can download Expect from its home page (http://expect.nist.gov/expect.tar.Z). Expect requires Tcl, which you can download from http://expect.nist.gov/tcl.tar.Z.

If loss of input is not tested for, and the input goes away, Expect prints the Tcl equivalent of a stack dump. This is an unpleasant result, so it is wise to always test for `eof` at the beginning of each `expect` statement and do something intelligent when the input is lost.

The `expect` statement is most easily used when human interaction is not required. Expect supplies an `interact` command for use when the default activity is interactive, yet the script must have the capability of selectively intercepting and acting on either user or program input.

`Interact` statements take the form:

```
interact [string1 body1] ...
[stringn [bodyn]]
```

which is similar to the `expect` statement except that the patterns are matched by default as simple strings rather than wildcard patterns. No arguments need be supplied. Another difference between the `interact` command and the `expect` command is that `interact` behaves as if it is in an infinite loop, while `expect` continues on to the next Tcl statement by default.

The simplest `interact` statement is a statement by itself. This ties the user's input to the process indicated by the `spawn_id` variable. For example, `spawn /bin/csh interact` ties the user to the shell such that it is not obvious that Expect is in the picture.

Also, there is no way to exit the process via Expect. A simple enhancement lets the user abort the process on demand:

```
spawn /bin/csh interact { "\033"
{ close; wait; exit } }
```

This script allows direct user interaction with the shell until you hit the Escape key. Then, the spawn ID associated with the shell is closed, causing it to exit. The `wait` command is executed to intercept the death of child and avoid a zombie process. Finally, you use the `exit` command to exit the script.

A popular use of Expect is for testing other software. Expect can supply specific outputs, given certain inputs. The figure "Expect Test-Bed" shows a setup that lets a user on a Unix workstation test an embedded computer. The embedded computer has an Ethernet interface, plus a serial interface for debugging. The Expect script spawns a special test program that applies complex inputs to the embedded computer, while the serial link verifies the resulting actions. The user can select from a suite of tests written in Expect to execute.

Expect is a complicated language that will take time for you to master. Expect's 108-KB manual page organizes commands in alphabetical order, with each command description referring to other commands. Tcl, on the other hand, is a much simpler language and can be described in a more linear fashion. As a result, you will likely master Tcl before you master Expect.

Futures

Both Expect and Tcl have continued to evolve. John Ousterhout is working at Sun Microsystems, and there are now ports of Tcl/Tk to Win32 and the Mac. Don Libes works at NIST and continues to enhance Expect's portability and capabilities. There is reputed to be an effort under way (outside NIST) to port Expect to Win32. Once this port becomes available, it will open up new avenues for Windows programmers. **B**

Bob Friesenhahn is a consulting writer for BYTE who specializes in Unix and TCP/IP networking-related topics. You can reach him by e-mail at **bfriesen@simple.dallas.tx.us**.

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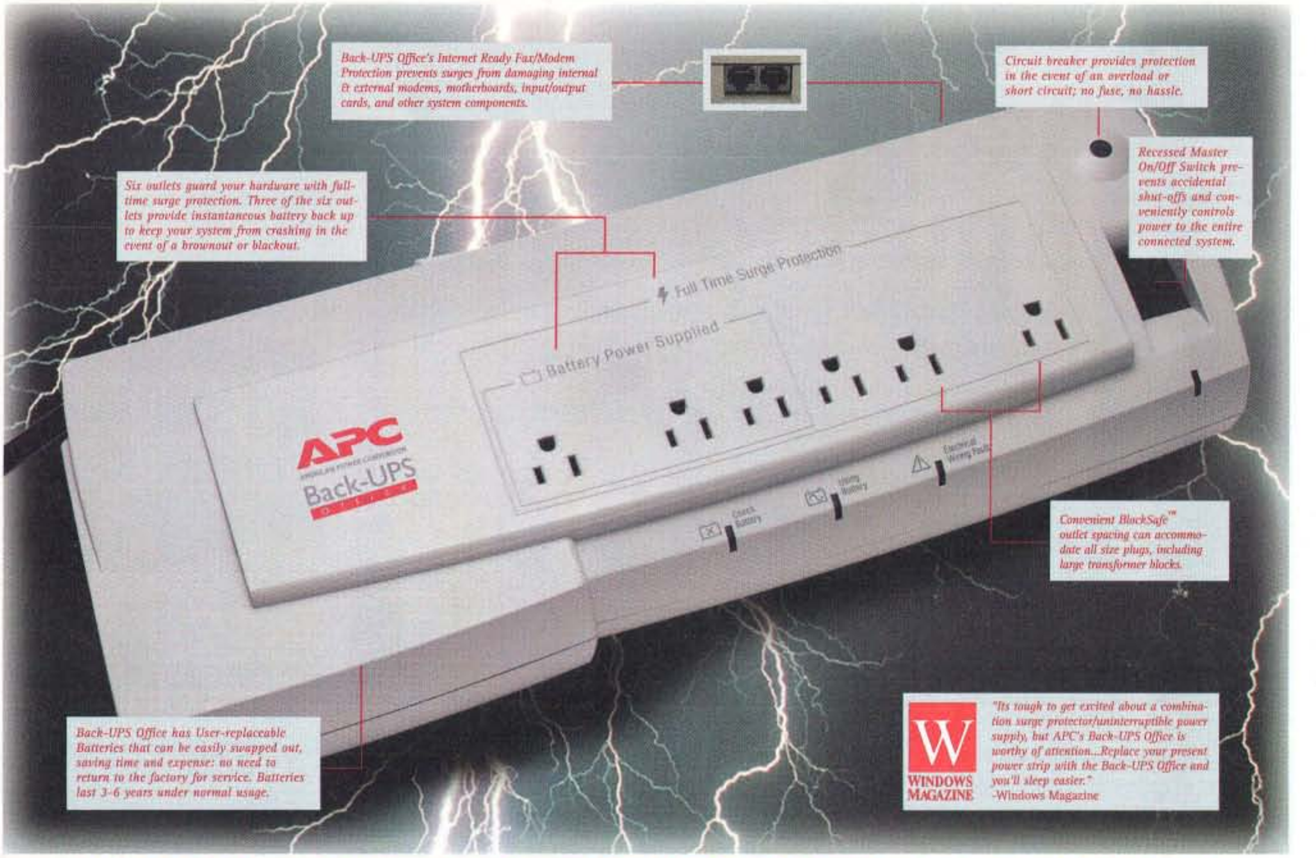

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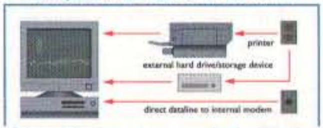
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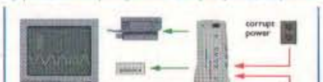

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Part I

Cheaper Computing

NCs vs. PCs? Ignore the propaganda; versatile PCs and low-cost thin clients both have a place in almost any organization.

By Tom R. Halfhill

If you really want to insult somebody in the computer industry, accuse that person of thinking like a stodgy data-processing manager from the dinosaur days of big iron. It's a well-worn weapon that both sides are wielding in the debate over personal computers versus network computers (NCs).

But which side is most guilty of mainframe mentality? The answer is not as obvious as it may seem. Intel and Microsoft, leading the charge against NCs, say the new devices are nothing more than throwbacks to the bad old days of centralized computing and dumb terminals. NCs will limit your options and steal your freedom, they argue.

IBM, Oracle, Sun, and others claim it's the Wintel empire that's old-fashioned. NCs will cut costs and simplify your life, proponents insist. And they point out that the arguments against NCs sound an awful lot like the discredited arguments against PCs—that simpler, less expensive computers just can't do anything useful.

Here's the truth: PCs and NCs are not an either-or choice. And neither type of machine is a one-size-fits-all solution. There's room for both in almost any organization. Contrary to what you may have heard, it's possible for a company to adopt NCs without smashing all its PCs with hammers and rewriting all its software in Java. PCs and NCs can peacefully coexist on the same networks, access the same data, and, in some cases, even run the same software. Open-minded MIS managers can save money and boost productivity by matching the appropriate computing device—PC or NC—to each worker's job and skills.

This month we'll describe how the technical efficiencies and cost savings of NCs can reduce computing maintenance and administrative costs for some IS operations. Next month we'll focus on what some people view as the less radical approach: finding ways to cut operational overhead for the typical networked PCs that are commonplace in businesses today. Both strategies offer strengths and weaknesses; to use either

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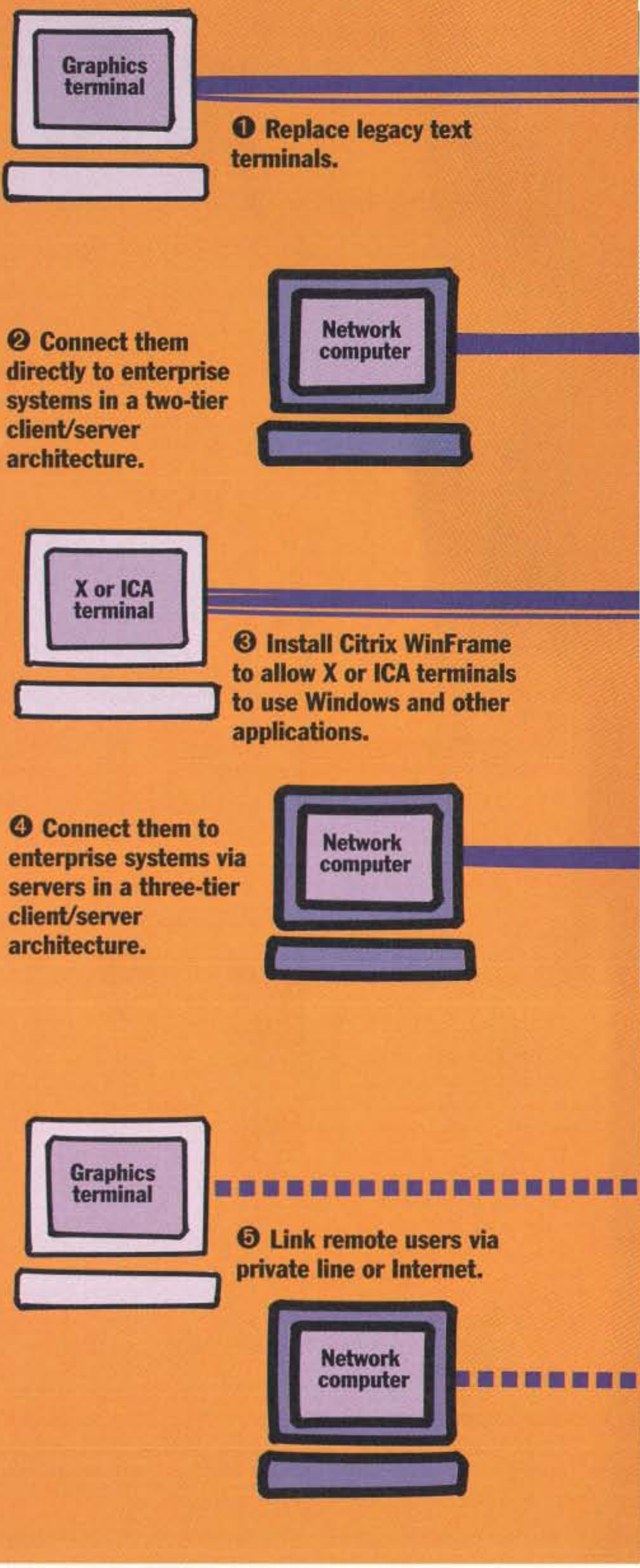

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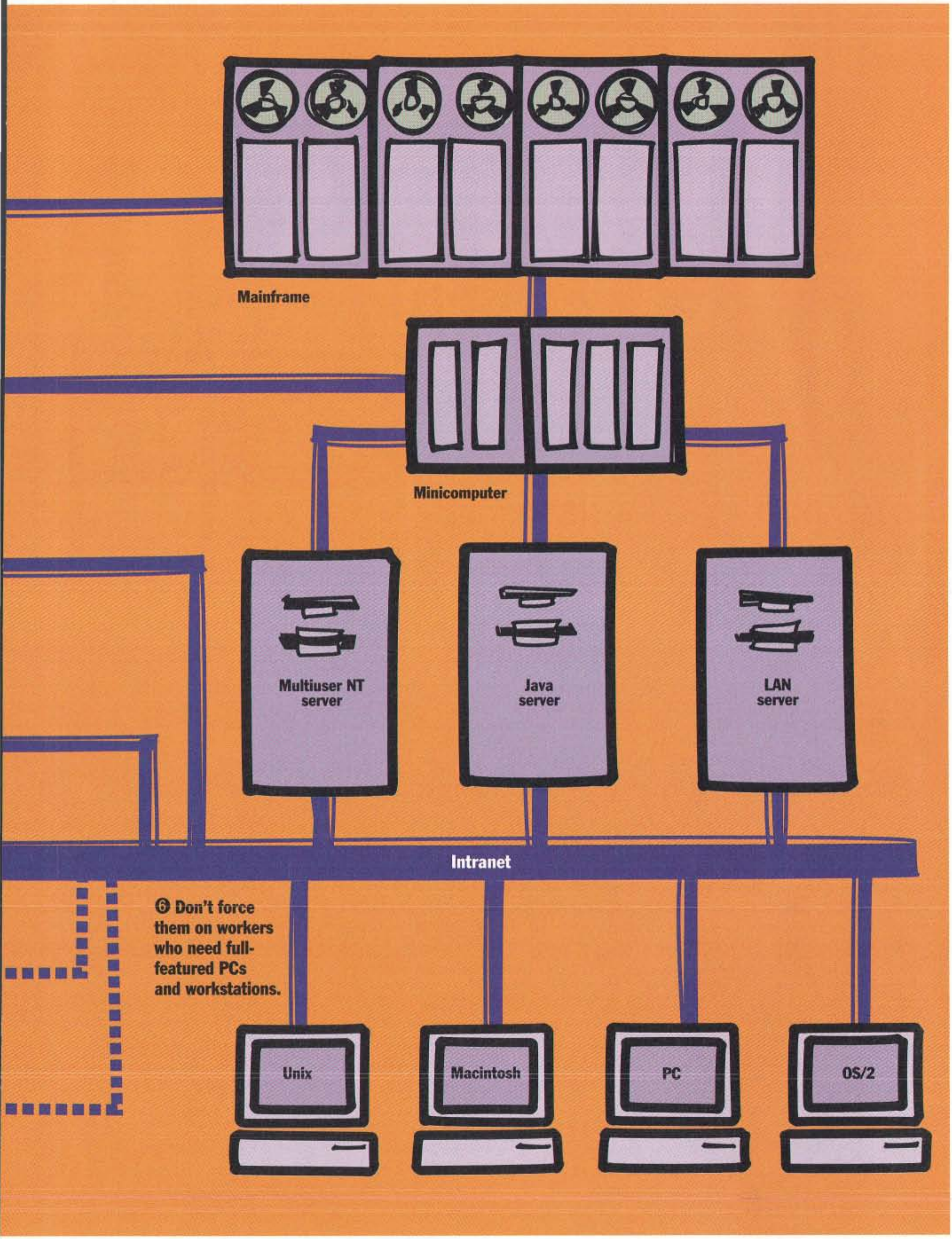
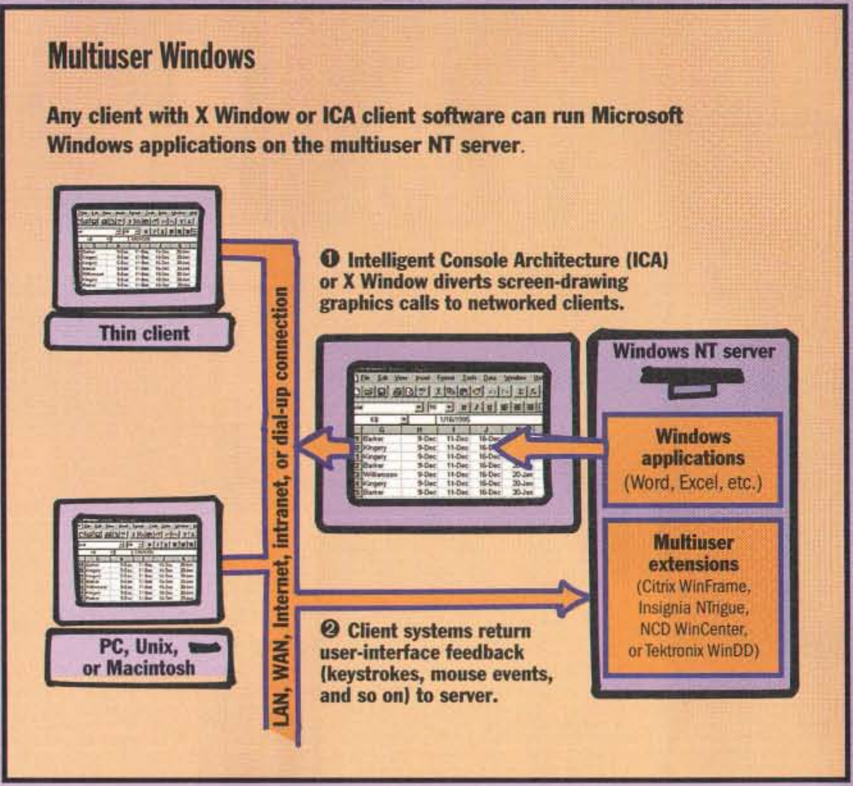
❹ Connect them to enterprise systems via servers in a three-tier client/server architecture.

❺ Link remote users via private line or Internet.



❻ Don't force them on workers who need full-featured PCs and workstations.

Windows Everywhere, Thanks to Citrix



Multiuser Windows

Any client with X Window or ICA client software can run Microsoft Windows applications on the multiuser NT server.

Thin client
LAN, WAN, Internet, intranet, or dial-up connection
❶ Intelligent Console Architecture (ICA) or X Window diverts screen-drawing graphics calls to networked clients.
Windows NT server
Windows applications (Word, Excel, etc.)
Multiuser extensions (Citrix WinFrame, Insignia NTrigue, NCD WinCenter, or Tektronix WinDD)
PC, Unix, or Macintosh
❷ Client systems return user-interface feedback (keystrokes, mouse events, and so on) to server.

Citrix WinFrame adds multiuser extensions for NT Server.

One company that's replacing Windows PCs with thin clients is Reinicke (Bogart, GA), which specializes in building pressed-board-lumber mills. With engineers scattered throughout the Americas—"where the trees are," explains Bobby Summerville, Reinicke's manager of engineering services—he can't fly someone out every time a PC has trouble. So, he's replacing the PCs with X Window System–compatible NCs from HDS Network Systems.

With 32 MB of RAM and a 17-inch color monitor, the HDS @workStation costs $1200—not much less than a PC. But the big win for Summerville is support. If anything goes wrong, the user can plug in a new box: All software and data resides on the server. "It makes the computer more like a phone," says Summerville. "It looks like a computer, but it's really a graphics phone."

Another engineering firm, Xtek (Cincinnati, OH), is also replacing PCs with X-compatible NCs. Xtek recently installed more than a dozen Network Computing Devices (NCD) machines connected to a pair of Silicon Graphics workstations and a dual-Pentium-90 NT server. Engineers use the NCs to run CAD programs on the workstations and Microsoft Office on the NT system. Pat Casey, Xtek's engineering systems administrator, says the NCs have won over his skeptical users and have eliminated the "hassles and problems" of PCs. "My management tasks are greatly reduced because I only have to upgrade the servers," he adds. "It's been great for me."

Under the Hood

Besides being NC early adopters, what do these two companies have in common? Underlying their thin clients is Citrix's WinFrame, which allows a network of client devices—of many hardware and OS types—to run programs on an NT server. The clients can be thin (under-$1000 graphics terminals, available from several vendors) or fat (ordinary PCs running the WinFrame client software). Users see a screen that's virtually indistinguishable from a PC running NT. They can launch 16- and 32-bit Windows programs, manipulate files, and do almost everything else a PC user can do. (See the figure above.)

It's startling to watch a $750 terminal or an ancient 286-based PC running the latest version of Word at Pentium speeds, but that's what WinFrame delivers. All the client device needs is the WinFrame client software, which is extremely lightweight. The DOS version requires only a 286, 1 MB of RAM, and a VGA card.

Citrix and its sublicensees (including Insignia Solutions, NCD, and Tektronix) offer WinFrame client software for DOS, Win16, Win32, OS/2, 680x0-based Macs, PowerPC-based Macs, and many Unix versions. As a Netscape plug-in and ActiveX control, Citrix can run Windows programs in a Web browser. It's built into thin clients from Wyse and Boundless, and a Java version is on the way. In all, WinFrame brings Windows to nearly a dozen different CPU architectures.

WinFrame is not an emulator; it's a client-neutral multiuser version of NT. Windows programs run natively at full speed on the server. The server also stores all the user's files and configuration data. When users log on, they get their own personalized Windows environment, just as they left it from their last session.

WinFrame has two components: MultiWin, which adds multiuser capabilities to NT Server; and the Intelligent Console Architecture (ICA), a Citrix protocol that lets NT distribute graphics processing to networked clients. ICA intercepts calls to the Windows Graphical Device Interface (GDI) and redirects them to the client, which shows the graphics on the local screen. The server renders the text and bit-mapped graphics to save time and enhance security. (Text travels on the wire as rendered graphics, not data, to thwart network eavesdropping.)

For 32-bit reentrant Windows programs, WinFrame needs to launch only one instance of the program to support multiple users. Otherwise, it must launch a separate instance for each user,

effectively, companies must make choices based on a clear technical understanding of each alternative.

What's an NC?

Something obscured by the debate is that all NCs are not the same. Some are radical new devices designed to run software written in Java, albeit with gateways to existing programs and data. These are the official Network Computers (an Oracle trademark) and JavaStations (a Sun trademark) supported by an alliance of like-minded vendors.

But there's a whole other class of machines that are true terminals in the classic sense: Unlike NCs, they don't execute programs on the desktop. Instead, applications run remotely on a multiuser server, and the client machine handles only the graphics locally. These machines offer a more conservative approach than true NCs because they're designed to run Windows and other popular software—albeit which requires more server memory. Citrix recommends 4 to 8 MB per user. Depending on usage and applications, a Pentium or Pentium Pro server can typically handle 15 or more users.

Application performance depends chiefly on the processing power of the server. The client machine's horsepower and the network's bandwidth are relatively minor factors. The ICA protocol is optimized for narrowband connections, requiring only 10 to 20 KB of bandwidth. It would take many ICA clients to bog down a typical 10-Mbps LAN. In fact, ICA even runs tolerably well over a 14.4- or 28.8-Kbps modem. Citrix's new version of ICA will take advantage of the greater bandwidth on LANs to deliver more performance.

X Marks the Spot

Sublicensees are extending WinFrame in all directions. For example, NCD's variation, WinCenter, converts ICA to X protocol. Insignia has a similar product, NTtrigue, and Tektronix has WinDD (short for Windows Distributed Desktop). They open up the world of Windows software to thin-client X terminals.

Thin-client technology is not necessarily opposed to PCs–it has wider possibilities. XpressNet (Danville, CA) recently introduced a WinFrame-based toolkit for creating on-line training courses. The toolkit includes a modified version of WinFrame, ICA client software (the Netscape plug-in or ActiveX control), Microsoft's FrontPage, and course templates written in Hypertext Markup Language (HTML) and JavaScript. Companies can design their own custom training courses for Windows programs and deliver the lessons to users without installing the Windows programs on the users' PCs. The programs run remotely in a separate Web-browser frame, next to the lesson. It's another example of how this technology can expand options, not limit them.

WinFrame's ability to deliver Windows over nearly any kind of network to almost any kind of client sounds eerily like the Java mantra. Although Microsoft is officially committed to PCs running their own copies of Windows and Windows applications, WinFrame adds a thin-client, multiplatform weapon to Microsoft's arsenal. It's not a true cross-platform solution, like Java is, and it's even more network-centric than the NCs from Oracle and Sun, but it's a useful alternative that only the stodgy would ignore.

remotely—rather than requiring new Java software. The applications run on a server, not on the desktop, which is why these machines are technically terminals, not computers. But they're not underpowered dumb terminals. Although they cost less to buy and support than a PC, they can actually run PC software as well as a PC can.

The generic term for these and the NC alternatives to the PC is *thin client* (see the figure "Thin and Fat Clients" on page 70). They're referred to as "thin" because they're generally less complex and less expensive than a PC. It's not a sexy name, to be sure, but we seem to be stuck with it.

Whether they represent a new paradigm or an updated twist on an old one, all thin clients have three things in common: They cost a little less to buy than a typical PC (though rarely as little as the magical $500 figure when configured for business); they cost less to support than a typical PC (5 percent to 40 percent less, according to industry analysts); and they're "stateless" machines that rely on servers to store all volatile data and software (except for stuff temporarily cached in RAM or on disk). In other words, thin clients are primarily designed to save administrative costs over the long haul, and they're interchangeable parts that are easy to replace when broken because they don't store information persistently.

Thin clients won't make PCs obsolete any more than PCs made mainframes obsolete. They're just one more computing option. "We tend to think mainframes were defeated by minicomputers, minis were defeated by PCs, and maybe PCs will be defeated by network computers," says John McCrea, a marketing manager at Silicon Graphics, Inc. (SGI). "But the topology of computing is actually very diverse. We've still got mainframes, we've still got minis, and we'll always have PCs. That diversity isn't going away, and I believe the topology will become even more diverse in the future."

Still, many people are skeptical. A recent survey done by market researcher Computer Intelligence of 319 technology decision-makers at large U.S. companies found that 42 percent of them had no plans to evaluate or adopt NCs in the next year. However, 51 percent of those same respondents were not familiar with NCs.

Thin clients aren't a pipe dream. In January, Sears agreed to buy 2500 machines from Boundless Technologies to replace PCs on token-ring networks in stores throughout the U.S. In December, AT&T announced it would spend $5.3 million on Boundless machines for its call centers. Barclay's Bank is using 15,000 thin clients made by Network Computing Devices (NCD); Federal Express has 10,000 thin clients, and the University of Washington has more than 1000. FTD is recommending the purchase of 17,000 Sun JavaStations to replace old PCs at florist shops nationwide. These and other companies are discovering that thin clients can save them money, too; see the text box "Thin Clients: Behind the Numbers" on page 70.

Intel and Microsoft take thin clients very seriously. Their initial reaction to the NC hype was to respond with a barrage of counter-hype (see the text box "10 Myths About Thin Clients" on page 74). Now they are striving to make PCs less costly to manage. Microsoft's Zero Administration for Windows (ZAW) and Intel's Wired for Management are two initiatives that address some of the criticisms leveled at PCs. They're also defining a diskless PC standard, called the NetPC, that's not as thin as a thin client, but not as fat as a PC (see the text box "The Wintel Empire Fights Back" on page 80). Even if your company never buys an NC, you'll benefit from the changes NCs will bring to PCs.

Deployment Decisions

The key to saving money with thin clients is knowing when to use them. Even the most rabid advocates don't suggest that thin clients will completely replace PCs for all purposes. Thin clients work best in the following situations.

When users work with a limited set of programs. Such users might range from low-level order-entry clerks to top-level executives. The key factor is that these users rarely need new applications, because thin clients normally don't let users install software that's not available on the server.

Shared desktops. The old business model of full-time employees and one person per office is giving way to a workplace with part-time employees, independent contractors, temporary workers, and telecommuters. It makes little sense to reserve a full-blown PC for everyone who might need occasional use of a computer at the office. Because thin clients are stateless, employees can share them and enjoy their own personalized working environment after logging on. And that same environment is available to them at home or on the road.

Remote users who are difficult to support. If a PC breaks down at a remote location, MIS must either send someone to fix the problem or talk the user through the repairs. Because thin clients lack extras such as persistent storage, there's less to go wrong with them. With a true hardware failure, MIS can easily replace a stateless

Thin Clients: Behind the Numbers

PCs are a pain in the wallet. At least that's what the analysts say.

At the center of the controversy over thin clients are some widely quoted–and frightening–studies on total cost of PC ownership: what it costs to manage, maintain, and replace PCs over the long haul. The Gartner Group, the most famous author of these studies, pegs the five-year cost of owning a PC with Windows 3.1 at $44,250. It's $38,900 for Windows 95 and $38,400 for Windows NT.

Zona Research studied the five-year cost of 15 Windows PCs with an NT server and compared it to the cost of 15 Wyse Winterm clients with an NT/WinFrame server. The result: PCs, $217,663; thin clients, $94,368. Other studies have come up with different numbers, but they've arrived at the same conclusions: Considering all factors, thin clients beat PCs hands down.

How do analysts arrive at those numbers? Are they reliable? What are the variables? While a detailed critique is beyond the scope of this article, it comes down to the following factors.

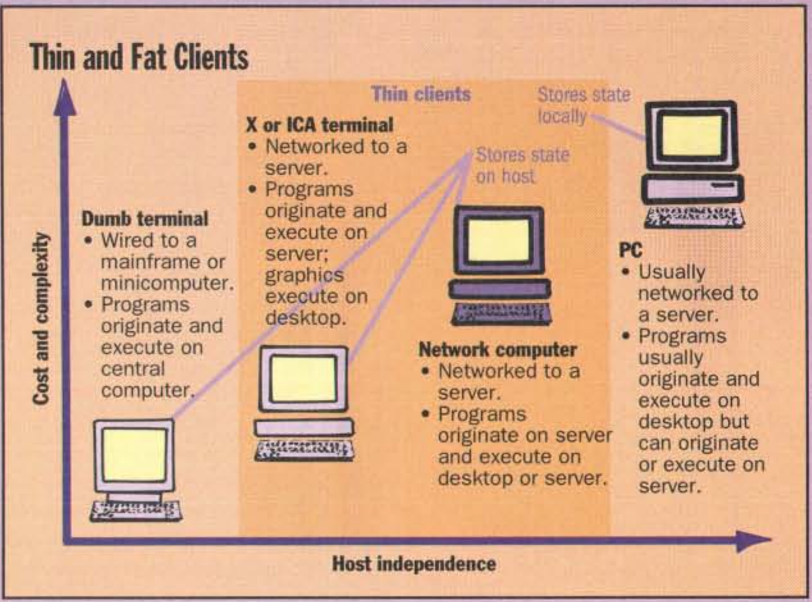
- PCs cost more to buy than thin clients, even after improving servers and networks for thin clients.
- PCs are more trouble prone, so they need more technical support.
- PC users often try to solve technical problems themselves–which sometimes makes the problems worse, and always interferes with their real jobs. Users–not MIS professionals–provide about two-thirds of their own support. In fact, users refer only one problem out of 10 to a help desk. Their first recourse: Summon the nearest geek. "Pretty soon you've got four people hanging around the computer, trying to fix it," says Gartner Group analyst Bill Kerwin. The loss of productivity and extra problems these users cause eventually cost the company 50 percent more than professional support.
- PCs are more difficult to use, so users require more instruction and training.
- PCs allow users to install their own software, which frequently leads to mishaps.
- PCs become obsolete faster; thus, businesses must replace them more often.

Interestingly, one way that thin clients *don't* save money is by reducing MIS staff–a relief to managers who resist thin clients because of secret fears their department will be downsized. In fact, according to Kerwin, "Well-managed PC environments and network-computer environments might actually *increase* the demand for centralized IS services because they move tech support to where it belongs–and where it costs less in the long run."

Thin clients are less troublesome to begin with, but when something does go wrong, it's usually on the server side–where users don't meddle. Greg Blatnik, an analyst for Zona Research, agrees, saying, "That eliminates a huge potential for headaches, problems, and administrative responsibilities, because the user doesn't have to act as his or her own system administrator."

Still, businesses can dramatically cut the costs of owning PCs by tightening their maintenance and administration practices and by managing better. The Gartner Group estimates that thin clients are 30 percent to 40 percent less expensive to own than PCs in a typical corporate environment, but in a well-managed environment they're only 5 percent to 15 percent less expensive.

That's why no analysts are predicting that thin clients will entirely replace PCs. But the Gartner Group estimates that thin clients will account for 20 percent to 30 percent of all desktop computer shipments by the year 2000.


Thin and Fat Clients
Thin clients
Stores state locally
Stores state on host
X or ICA terminal
• Networked to a server.
• Programs originate and execute on server; graphics execute on desktop.
Dumb terminal
• Wired to a mainframe or minicomputer.
• Programs originate and execute on central computer.
Network computer
• Networked to a server.
• Programs originate on server and execute on desktop or server.
PC
• Usually networked to a server.
• Programs usually originate and execute on desktop but can originate or execute on server.
Cost and complexity
Host independence

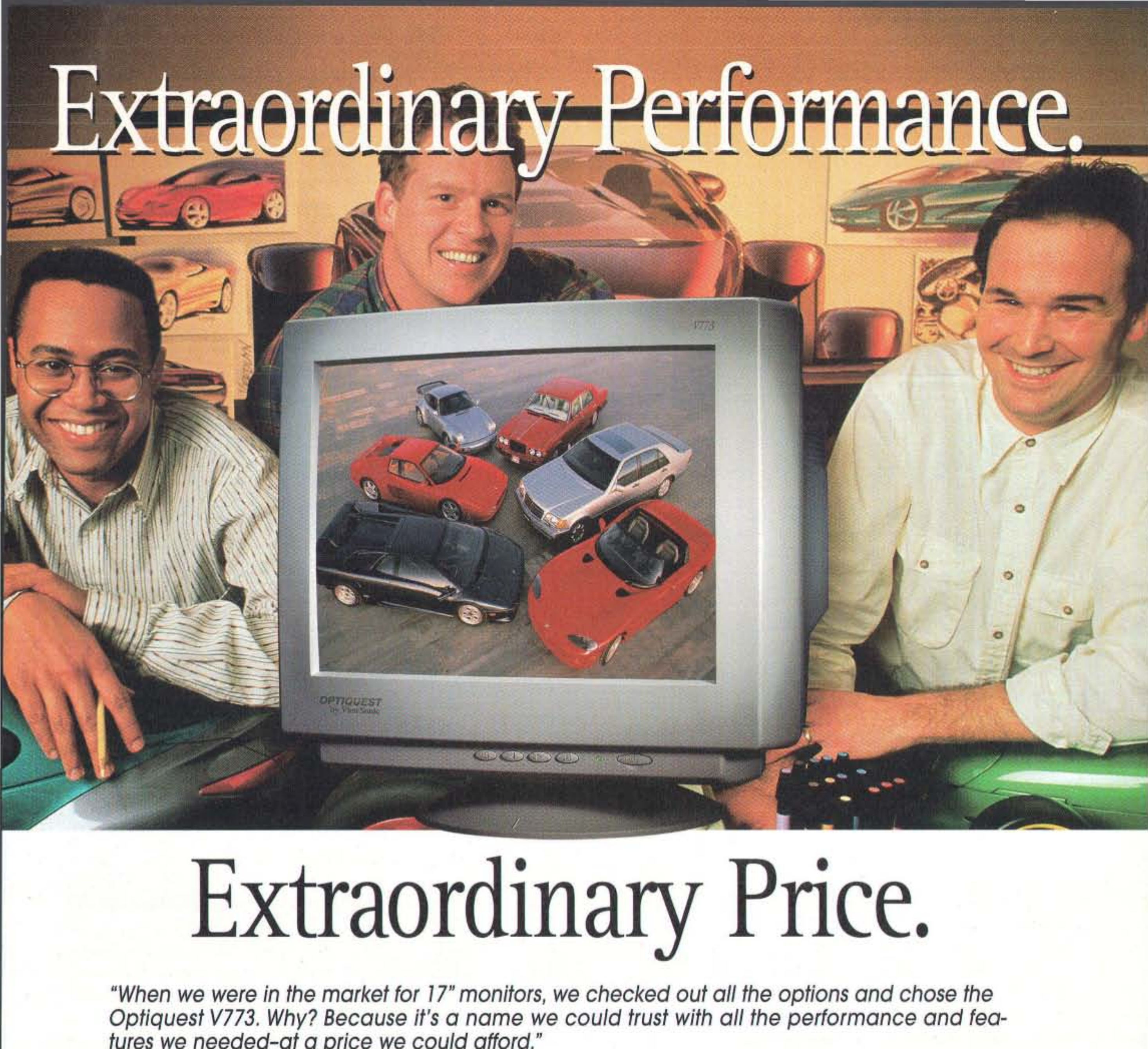
Client systems range from dumb terminals to mostly autonomous PCs. Thin clients fall in between.

client with a new machine because there's no local software or data files to restore.

Jobs that revolve around remote data instead of local data. An order-entry person who spends the day checking data in a centralized database and filling in electronic forms is well served by a simple, foolproof machine. So is a factory foreman who needs to view the latest engineering drawings in a database. These jobs are highly specific and network-centric, so the workers aren't sacrificing flexibility by switching to a network-centric device.

Whenever security is paramount. Conventional desktop and laptop PCs can be security nightmares because they store everything locally and users have virtually unrestricted access to local storage. Every loss, theft, virus attack, breakdown, or break-in is potentially catastrophic if it endangers strategic data. Thin clients that store everything on a server are generally safer because server closets are more physically secure and professionals regularly back up the servers. The only caveat is that network-centric clients might be more vulnerable to network snooping—but networked PCs aren't immune to that, either.

Replacements for older, text-based terminals. Analysts estimate there are 30 million to 50 million dumb terminals installed worldwide. These include IBM 3270 and 5250 terminals, VT-series terminals, and



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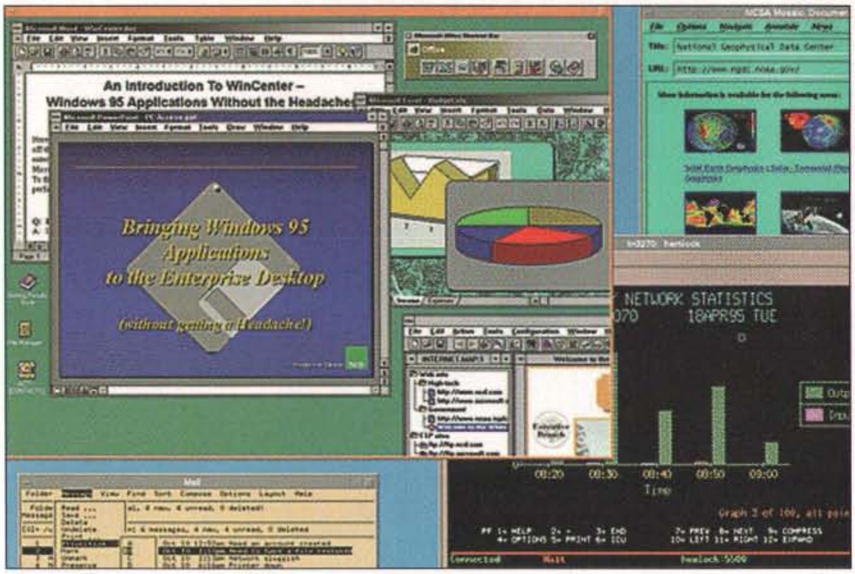
similar ASCII/ANSI devices. Today's thin clients can use the same legacy programs and data that these dumb terminals use, yet they provide a GUI, as well as access to the Internet and corporate intranets. Thus, as more business resources (e.g., e-mail, company directories, and internal discussion groups) migrate to intranets, and as more enterprises deploy applications on new platforms, such as Windows NT, thin clients allow more possibilities than dedicated terminals. "Intranets are becoming a vital part of the corporate infrastructure," notes Dave Folger, an analyst with the Meta Group.

On the flip side, thin clients are not well suited for users who need lots of local processing power, who frequently need to install new software, who use a variety of peripherals, or who don't have access to a network that's fast enough to run network-centric applications. For example, a graphic artist who uses Adobe Photoshop to scan and edit artwork needs a powerful PC. Software developers who frequently install new programming tools and utilities need more local control over their systems. Telecommuters who rely on slow dial-up connections may or may not be able to get by with an NC, depending on the types of applications they're running. For reasons that are both technical and psychological, many users who have a choice will always prefer a PC.

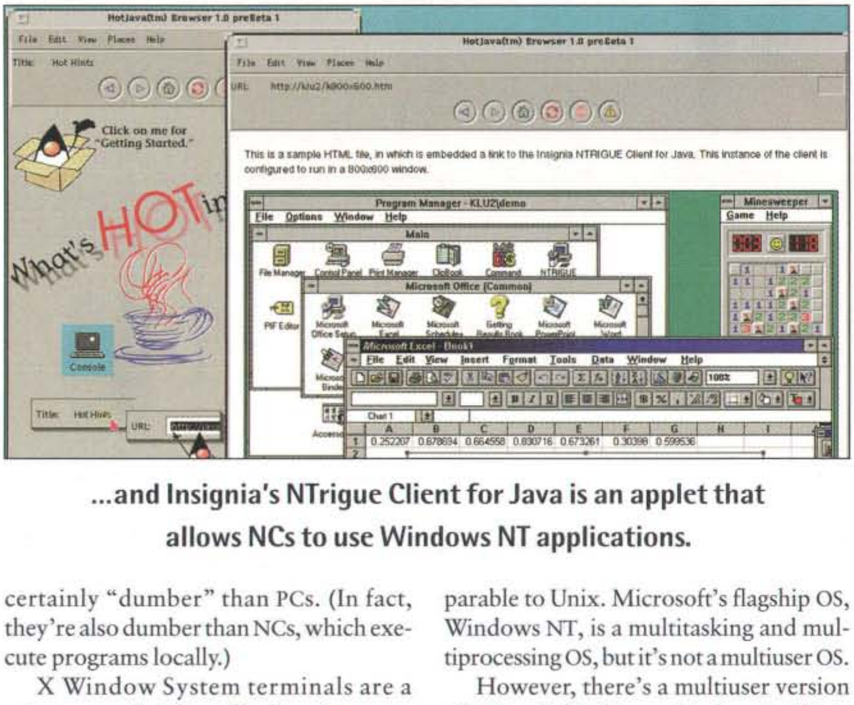
However, as the technology continues to advance, and as computers penetrate deeper into organizations, the percentage of users who absolutely must have a PC will decrease. The first people who got PCs tended to be *knowledge workers*—users who organize or create information. As PCs became more pervasive, they appeared on the desks of workers who need to merely access information or perform other nonstrenuous computer tasks, such as using e-mail. Many of those tasks require a network, but not an expensive PC. That's why it's not going out on a limb to predict a fat future for thin clients.



An Introduction To WinCenter – Windows 95 Applications Without the Headache

Bringing Windows 95 Applications to the Enterprise Desktop (without getting a Headache!)

Two NT choices: NCD's WinCenter runs applications on an NT server and converts user-interface requests into X Window System calls...



This is a sample HTML file, in which is embedded a link to the Insignia NTRIGUE Client for Java. This instance of the client is configured to run in a 800x600 window.

HotJava(tm) Browser 1.0 prebeta 1
File Edit View Places Help
Hot Hints
Click on me for "Getting Started."
What's HOT
Console
Program Manager - KLUZ\demo
File Options Window Help
Main
Microsoft Office (Common)
Microsoft Excel - Book1
File Edit View Insert Format Tools Data Window Help
Minesweeper
Game Help

...and Insignia's NTrigue Client for Java is an applet that allows NCs to use Windows NT applications.

Anorexic Clients

The thinnest clients of all are terminals that handle the graphics display locally for programs that execute remotely on a multiuser server. Technically, they're not dumb terminals because dumb terminals are just keyboards and screens wired up to a central computer; they don't process graphics locally, and they're not on a LAN. Nevertheless, these graphics terminals are certainly "dumber" than PCs. (In fact, they're also dumber than NCs, which execute programs locally.)

X Window System terminals are a prime example. They offer the advantages of a thin client—lower acquisition and support costs and stateless operation—without the more radical commitment to Java implicit in the Oracle/Sun NCs. For this reason, terminals might be easier to integrate with existing environments.

Some people associate these terminals exclusively with X and Unix, concluding they're not an option for corporate environments based on Microsoft Windows. It's an understandable assumption because Microsoft doesn't sell a multiuser OS comparable to Unix. Microsoft's flagship OS, Windows NT, is a multitasking and multiprocessing OS, but it's not a multiuser OS.

However, there's a multiuser version of NT available from a third party: Citrix Systems. Citrix is a relatively small company that enjoys an unusual relationship with Microsoft. Microsoft owns a piece of Citrix and sits on Citrix's board of directors. More important, Microsoft has granted Citrix a source-code license and a distribution license for Windows NT Server. Nobody else has such a license. It allows Citrix to modify NT, resell it to customers, and sublicense it to other companies.

Citrix has used this license to create a multiuser version of NT Server known as

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WinFrame, which Citrix's sublicensees modify. So, while Microsoft denounces NCs in public, it supports even thinner clients than those championed by Oracle and Sun (see the text box "Windows Everywhere, Thanks to Citrix" on page 68).

The key difference from Microsoft's view is that WinFrame terminals are primarily designed to run Windows programs, while NCs are primarily designed to run Java programs. Microsoft embraces Java as a development language but abhors it as a platform. WinFrame delivers Windows software to many different platforms—including non-PC platforms, such as thin clients—while defending Windows as the dominant OS. Java, as a platform, potentially threatens that dominance (see "Today the Web, Tomorrow the World," January BYTE).

10 Myths About Thin Clients

1.

They're dumb terminals. Anyone who says this either doesn't know what he or she is talking about or hopes you don't. True, some thin clients are smart graphics terminals, but all NCs are computers.

2.

They're stripped-down PCs. That's like saying a PC is a stripped-down minicomputer. Actually, some NCs are faster than PCs because they can use any CPU or OS.

3.

They'll replace PCs. Thin clients can replace PCs for some purposes, but they'll never replace them for all purposes.

4.

They're only for home users. NC vendors have always identified three markets: business, home, and education.

5.

They're only for surfing the Web. That would come as a surprise to the many vendors of business software for thin clients.

6.

They use TVs as display devices. While some low-end NCs for consumers might only use a TV, all thin clients for the corporate market work with standard video monitors at standard resolutions.

7.

They cost $500. NCs for the consumer market typically cost $500 (or less), but business systems usually cost between $750 and $1200. They save companies money by reducing administrative costs more than acquisition costs.

8.

No hard drives. Hard drives are optional. When present, a hard drive caches programs and data; persistent copies reside on a server. This eliminates the biggest source of problems with PCs: persistent local storage, which entails software installation, software conflicts, viruses, corrupted files, obsolete software, and so forth.

9.

They take 15 minutes to boot up. NCs based on Oracle's reference design store the OS and key applications in ROM, so they start instantly. Others take no longer to boot than a PC. (Have you booted Windows 95 lately?)

10.

They're not mobile. There's no reason why a mobile NC can't cache files and software on a hard drive while untethered to a network. There's also no reason why people can't keep using mobile PCs, even if they have NCs back at the office.

Java-Centric NCs

Of course, most of the hype about thin clients originated from Oracle and Sun, who are pushing the concept of NCs that run Java. Programs written in Java can execute without recompiling on any platform that has a Java run-time environment. Oracle's NC standard doesn't prohibit NCs from also running native software, such as Windows, but it's definitely oriented toward Java. In this sense, Oracle and Sun are taking a more radical approach because they are betting on the success of Java as a universal platform.

In another sense, NCs are less radical than graphics terminals connected to multiuser servers. Java programs execute on the desktop, not on a server, so NCs are real computers, not terminals. While it's true that Java programs often arrive over a network from a server, there is nothing revolutionary about networks and applications servers. Also, NCs fit into the two- and three-tiered client/server models: Users can manipulate centralized data with a Java program directly from their desktops or through a middle-tier server that's exposing a server-side application to a Java applet. Nothing revolutionary there, either.

The great advantage of Java-centric NCs—in addition to the usual advantages of thin clients—is that Java programs are decoupled from the OS and CPU. Everything below the Java virtual machine (VM) can change without breaking applications (see the figure "The Java Platform" on page 76). That gives users and NC vendors unprecedented freedom to adopt whatever OS or CPU is their best option.

The disadvantage of Java-centric NCs is that some designs require new software written in Java. But NCs don't burn all bridges behind them. Numerous gateways to existing databases and applications are popping up. Java programs can already access just about any database through Java Database Connectivity (JDBC) drivers and middleware, such as Symantec's dbAnywhere and The Santa Cruz Operation's (SCO's) SQL Retriever IV.

More amazing are the new Java gateways to non-Java software, including programs written for Windows, Unix, X, and mainframes. Three examples are Tri-Teal's SoftNC, SCO's Tarantella, and Insignia's NTrigue Client for Java. All use Java to impersonate an X terminal or even a text-based dumb terminal on an NC. The Java programs link to server-side components, which in turn run a non-Java program on a server or a mainframe.

It sounds impossible, but you'll soon be able to run Windows, mainframe applications, or just about anything else on a Java-centric NC over a network. Because the non-Java program executes on the server or mainframe, it performs at native server speeds, although prerelease versions of the Java gateways are noticeably slow at redrawing the screen.

SoftNC is a complete desktop environment written in Java that can mimic the look of Windows 95, Motif, or the Unix Common Desktop Environment. By using various Java programs, SoftNC provides portals to Windows, Unix, 3270, and 5250 applications. Fujitsu, NCD, and Wyse all license SoftNC for their thin clients.

The first release of Tarantella (scheduled for the first half of this year) will run Unix character-based programs and X graphics programs on NCs. A follow-up

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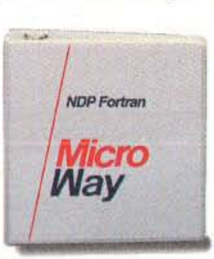

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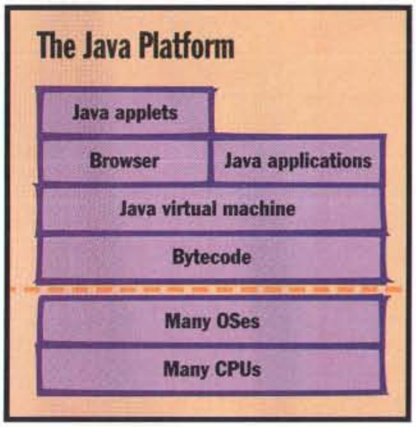
version of this Java applet will add support for IBM 3270 and 5250. The third release, due by September, will run Windows (see the figure "Multiplatform Tarantella" at right).

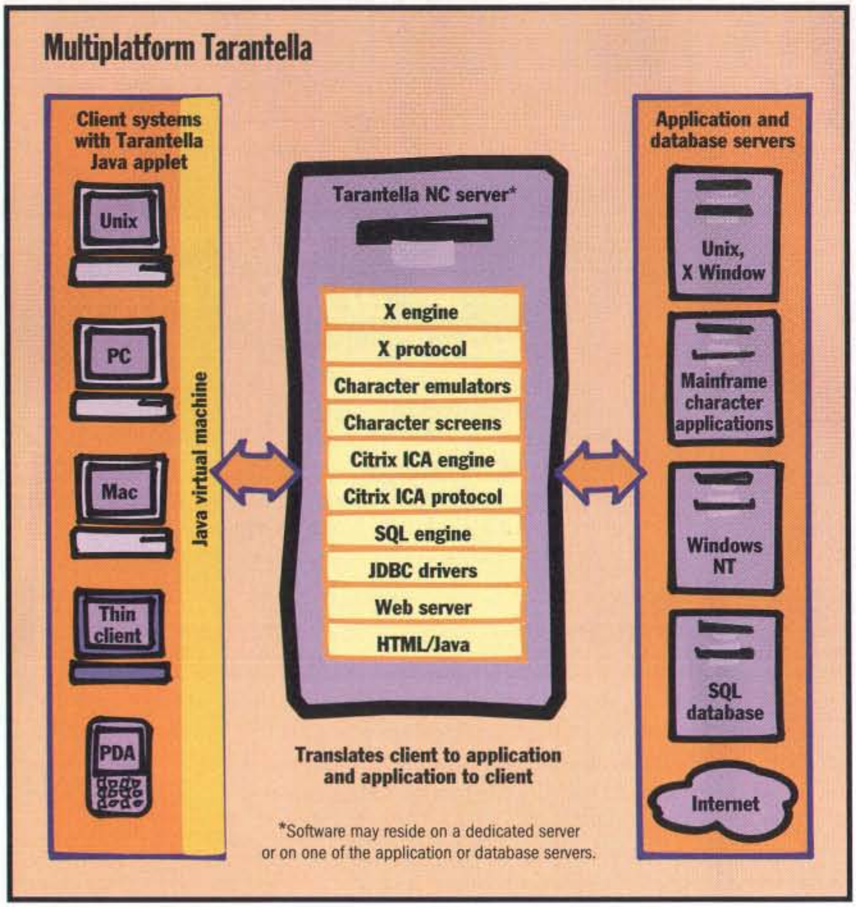
Insignia's Java applet, which runs only Windows, is also slated for release in the first half of this year. It will be bundled with Sun JavaStations. It's less than 100 KB in size and uses an optimized version of X that strips out all the graphics calls duplicated in Java's Abstract Windowing Toolkit (AWT), the class library that provides GUI services to Java.

During one demo, an Insignia engineer launched Sun's HotJava browser on a JavaStation and ran the NTrigue Java applet inside the browser (see the screen on page 72). This opened a gateway to an NT server, on which he ran Excel. Then he launched the Windows version of Netscape Navigator. Now he had a browser running within a browser (HotJava running locally on the NC, and Navigator running remotely on the server). Using Navigator, he ran another instance of the NTrigue Java applet, which in turn opened a gateway to another instance of Windows. And so on.

One point of this impressive demo is that recursion is hypnotic. Another is that Java-centric NCs can mesh with existing environments wherever they make sense. They won't force anyone to rewrite all their software in Java or ditch their PCs. NCs merely expand the client model—they don't change the client/server, network, or enterprise models.



Java abstracts everything below the dotted line.



Any client system with SCO's Tarantella Java applet will use applications from multiple platforms.

Science vs. Superstition

Confusion abounds over what exactly constitutes an Oracle-standard NC. Oracle's NC Reference Profile is explicit, but it also casts a broad net. Most PCs (including Microsoft's proposed NetPC) meet the Oracle NC standard if they've got a Web browser, Eudora, and a Java run-time environment (see "Inside the NC," November 1996 BYTE).

Microsoft rips NCs because they don't standardize on a single OS or CPU. Some critics trash NCs as stripped-down PCs. Others believe NCs can't have hard drives and work only with TVs. Still others are fixated on the widely quoted $500 price tag, declaring that any NC costing a penny more is a phony. Microsoft warns that NCs will force developers to use Java.

Some critics are victims of misinformation; others just don't get it. First, the deliberate lack of an OS or CPU standard is a huge advantage: The OS and CPU barely matter because Java abstracts everything below the VM. While 90 percent of PC users are locked into a single-source vendor for their OS and CPU, NC vendors can swap those parts anytime without breaking software. Users don't have to worry about the inner workings of their NC any more than they have to worry about what's inside their cellular phone or VCR.

Second, NCs are stripped-down PCs in the same way that PCs are stripped-down minicomputers and that minis are stripped-down mainframes. In other words, that's the point. But thinner doesn't always mean slower. NCs with StrongARM processors, which can attain 233 MIPS, outrun all but the fastest PCs at a fraction of the cost. NCs can have hard drives, and they work with standard video monitors. Some NCs (especially those for the consumer market) actually cost $500 or less. NCs for the business market—designed to cut long-term administration costs, not just acquisition costs—typically cost around $1000.

Finally, we've already seen how organizations can integrate NCs without abandoning PCs and rewriting everything in Java. Java's cross-platform compatibility is compelling, but it requires developers to learn Java. Or does it?

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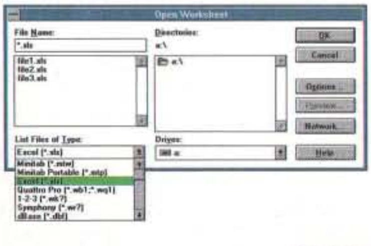

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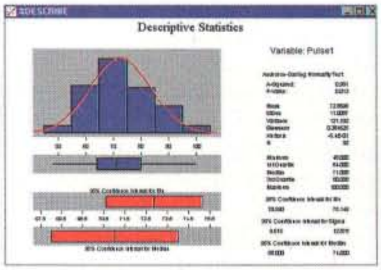

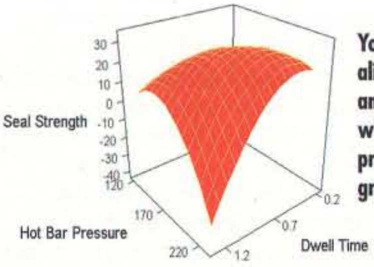

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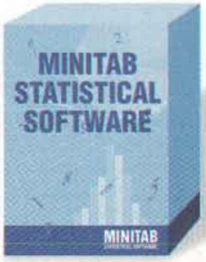

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Five thin clients, clockwise from top: the Wyse WinTerm 4700SE (built into a video monitor); the Boundless Technologies TC; Sun's JavaStation; and Akai's Internet Connection N|C. Center: The NCD Explora.

The Java VM is a platform implemented in software, and Java bytecode is the native instruction set for that platform. Compilers for other languages can target bytecode, just as they target any other instruction set. It's already been done: Intermetrics has an Ada compiler that produces Java bytecode. Parc Place/DigiTalk has experimented with a Smalltalk-to-bytecode compiler. Theoretically, a C++ compiler could do the same. James Gosling, who led the development team at Sun that invented Java, thinks Microsoft's Visual Basic could even output bytecode. (That probably won't happen, but for reasons that are more political than technical.)

NC Trends

In 1995, Oracle promised that NCs would ship by fall 1996. Oracle's prophecy came true—thanks to enterprising vendors who created their own designs. Last September, HDS Network Systems began shipping the @workStation, a hybrid X terminal and Oracle-compliant NC. Prices start at $749 for an Intel 960–based system with 8 MB of RAM. In December, Sun began shipping the JavaStation at a base price of $742 with 8 MB of RAM and a MicroSparc II processor. And early this year, Wyse began shipping the Winterm 4000, with a StrongARM processor and 8 MB of RAM, for $750.

Although these machines comply with Oracle's NC Reference Profile, they're not based on Oracle's hardware reference design. The NC Reference Profile merely defines the minimum requirements for an NC, while the hardware reference design is a complete motherboard that a manufacturer can license and copy.

Acorn produced Oracle's first reference design using the ARM 7500FE, a highly integrated chip that includes a CPU; I/O, memory, and video controllers; and audio functions. This NC has been in production since last August, but only in small numbers for trial purposes. Several trials are under way, particularly with Internet service providers (ISPs) who want to bundle NCs with Internet access for a flat-rate monthly charge. One such ISP is NetChannel. It's working with NChannel, a U.K. company that began mass-producing NCs early this year.

Three Designs

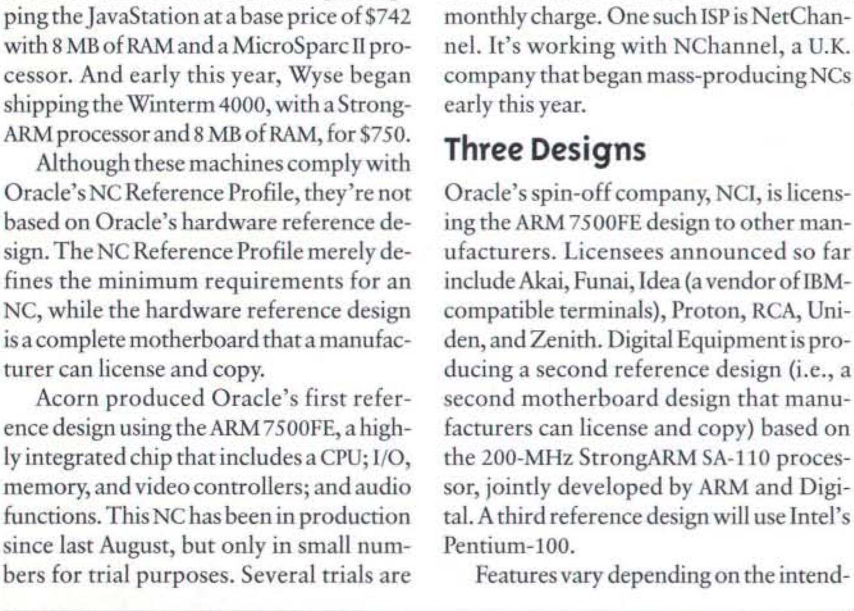
Oracle's spin-off company, NCI, is licensing the ARM 7500FE design to other manufacturers. Licensees announced so far include Akai, Funai, Idea (a vendor of IBM-compatible terminals), Proton, RCA, Uniden, and Zenith. Digital Equipment is producing a second reference design (i.e., a second motherboard design that manufacturers can license and copy) based on the 200-MHz StrongARM SA-110 processor, jointly developed by ARM and Digital. A third reference design will use Intel's Pentium-100.

Features vary depending on the intended market, but all NCI-licensed designs are similar. They typically have 4 to 64 MB of RAM, an 8-MB ROM card, a SmartCard slot, infrared and network interfaces, a parallel port, and a pair of PS/2-compatible I/O ports for connecting a mouse and keyboard.

The SmartCard slot allows multiple users to share an NC by storing their profiles on a SmartCard; it also offers interesting possibilities for on-line commerce by enabling secure electronic transactions. The infrared port is for wireless remote controls and joysticks. The network interface supports Ethernet, asynchronous transfer mode (ATM), ISDN, or a modem. The parallel port works with built-in drivers for popular printers and Iomega Zip drives. (Users can download additional drivers if necessary.)

The ROM card holds Oracle's NCOS (a multitasking OS based on Acorn's RISC-OS for ARM), a Web browser, a word processor that saves files in Word format, a Java run-time environment, a MacroMedia Shockwave player, and a MIDI synthesizer. Users can update the software by downloading patches into RAM or by swapping ROM cards.

Hard drives are optional and are always used for caching; users store their files on a server. The only exception to this rule is that a mobile NC would temporarily store data files (and some software) on disk between network sessions. A mobile NC must store some state between network con-



Rear view of Akai's Internet Connection N|C.

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The Wintel Empire Fights Back

Intel and Microsoft are spearheading several counterattacks against thin clients. Some of these attacks seem contradictory and make it appear that the two industry leaders are positioning themselves for every possible outcome—including the success of thin clients. Not a bad betting strategy.

Their initial reaction was to ridicule the thin-client idea. High-visibility personalities—including Microsoft CEO Bill Gates, Intel CEO Andy Grove, and Microsoft vice president Nathan Myhrvold—used industry forums and interviews to bash the notion that simpler, less expensive computers could replace PCs. At times, their protests were so strident that they appeared technically inept. The founders of the PC industry should know the difference between a dumb terminal and a computer.

Although that propaganda line continues, Intel and Microsoft are also taking more credible steps to defend PCs. Recognizing that total cost of ownership is a genuine issue, they're striving to make PCs easier to manage. Their most recent initiatives are the NetPC, Zero Administration for Windows (ZAW), and Wired for Management. In addition, both companies are hedging their bets by providing technology for thin clients behind the scenes.

Intel's and Microsoft's most ironic counterattack is the NetPC. While both companies loudly criticize NCs as "stripped-down PCs," their own NetPC proposal fits that description more literally than the Oracle/Sun NC. Simply put, a NetPC is a PC without a floppy drive. It will most likely have a hard drive, but for caching purposes only; a NetPC keeps copies of all user files, configuration data, and software on a server. (Sound familiar? NCs with hard drives work the same way.) Also, administrators can "lock down" NetPCs to prevent users from tampering with system settings.

The main difference between a NetPC and an Oracle/Sun NC is that NetPCs adhere to the industry-standard PC system architecture, while NCs are entirely new designs. Microsoft's proposed NetPC specification calls for a 100-MHz Pentium CPU, 16 MB of RAM, and Windows. A NetPC mainly runs Windows software, offering Java compatibility as a bonus—a stark contrast to Java-centric NCs.

The mechanism that allows NetPCs (and regular PCs) to "reflect" (i.e., duplicate) their state on a server will be Microsoft's ZAW. It'll be built into Windows NT Server 5.0 later this year, with client software added to the desktop versions of NT 5.0 and Windows 97. ZAW is a collection of components—not a single product—partly based on Active Directory (Microsoft's advanced directory services) and the Microsoft Management console. It will let users share systems and let administrators automatically distribute software updates.

"ZAW frees up administrators to focus on the administration tasks they really need to spend time on, such as supporting end users or spending more time planning infrastructure," says Victor Raisys, lead product manager for Microsoft's systems-management products.

Wired for Management is an Intel initiative (backed by Compaq, Hewlett-Packard, IBM, Microsoft, and others) whose goal is to reduce the cost of PC ownership by 15 percent within a year. Intel is attacking the problem on three fronts: by adding new features to hardware and software so that administrators can remotely control PCs and servers; by developing new management tools for remote installation, configuration, and management; and by integrating PC management into enterprise systems. (BYTE's working on in-depth coverage of these and other solutions for next month's issue.)

Meanwhile, Microsoft and Intel are not ignoring the possibility that thin clients might take off. Microsoft licenses Windows NT to Citrix Systems (see the text box "Windows Everywhere, Thanks to Citrix" on page 68), which resells and sublicenses a multiuser version of the OS for thin clients (see the main text for details). Microsoft has also invested in Citrix and in WebTV, a company that designs and licenses under-$500 Web-browser computers for the consumer market. Intel has been working with Oracle to develop an NC reference system with a Pentium-100 processor. But officially, both Intel and Microsoft discourage alternatives to traditional PCs.

nections. But that volatile state is immediately uploaded to the server the next time you connect to a network.

Mainframe Mentality

NCs will succeed if they can overcome all the prejudice. Their biggest obstacle is the tired argument that a simpler computer can't do some of the work that a more complex computer can do. It's been disproved again and again as computers have downsized from mainframes to minicomputers to PCs. NCs are simply the next logical step in the computer evolution that's been going on for half a century.

Of all the arguments against NCs, the only one that holds water is that NCs are more dependent on networks than PCs are. They are, after all, network-centric computers; there's no doubt that NCs work better on fast networks and that network outages can bring NCs to a screeching halt.

But PCs are becoming more network-centric, too. More to the point, applications are becoming more network-centric. If a task relies on access to a centralized database, a client/server application, an intranet, or the Internet, it doesn't matter whether the client is an NC or a PC. A network outage will idle either kind of machine. With a graphics terminal, you can't work when the network is down, but with an NC you can still run programs locally.

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Dependence on networks is nothing new. Businesses already depend on electrical networks, PBX networks, public telephone networks, and transportation networks. Computer networks are just one more infrastructure that businesses must rely on skilled professionals to maintain.

Most curious is the desire to standardize on one OS and one CPU architecture. Depending on a single company for all future OS innovation and on another for all future CPU innovation would be tragic for an industry driven by technology.

There's room in the world for all kinds of computers: supercomputers, minicomputers, mainframes, PCs, laptops, handhelds, game machines, you name it. NCs will find their place, too. B

Tom R. Halfhill is a BYTE senior editor based in San Mateo, California. You can reach him at **thalfhill@bix.com.**

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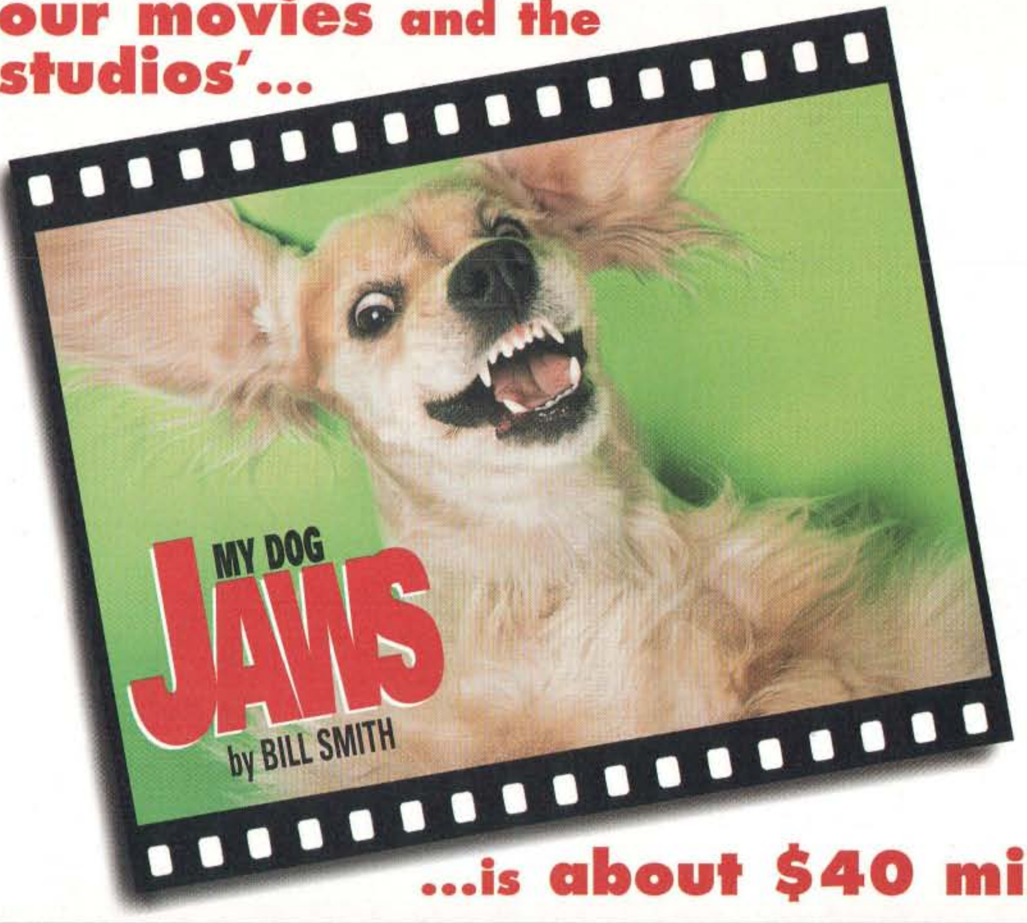

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Faster, Smarter Nets

Switched ATM is fast, but not that smart. Routed IP is smart, but not that fast. Why not combine them?

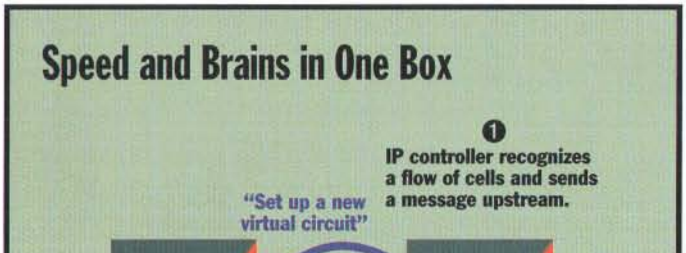
By Michael Hurwicz

Conventional wisdom in recent years has been that asynchronous transfer mode (ATM) will be the network technology of the future. Despite its strengths, ATM is not spreading like wildfire beyond the backbone. And the current boom in the Internet has made IP an ever-more vital protocol.

"I've heard it said that we don't know what the most popular programming language of the future will be, but we know it will be called COBOL. I don't know what the dominant networking protocol of the future will be, but I know it will be called IP," says Scott Bradner, senior technical consultant, Harvard Office of Information Technology.

In part, that's because many networks are doing fine at the building or campus level with IP. With 100 Mbps as an upgrade to Ethernet (and Gigabit Ethernet in the wings), bandwidth is not an issue in most LANs.

But what about the backbone and the WAN, where bandwidth can be a crisis? Exploiting public ATM services would solve that problem—but it also would create a host of new problems that all have to do with mapping today's routed, segmented, flow-controlled, connectionless IP world to ATM's point-to-point, connection-oriented world.



Speed and Brains in One Box

❶ IP controller recognizes a flow of cells and sends a message upstream.

❷ Flow is quickly routed to correct ATM port. Downstream switch has sent a message requesting virtual circuit.

The problem with trying to run IP over ATM stems from the different natures of the two protocols. ATM is a link layer protocol, like Ethernet or Token Ring, in charge of moving data between two nodes connected to the same medium. IP is a network layer protocol that gets encapsulated within ATM cells for forwarding. IP is connectionless, moving individual datagrams from one host to another; it runs easily over broadcast media like Ethernet, where you don't need to set up and break down circuits between source and destination hosts. ATM depends on point-to-point virtual circuits (VCs): Sending an IP datagram means setting up a circuit, breaking down the datagram into 53-byte cells (5 bytes of header and 48 bytes of payload), and shooting them across the VC; once the datagram is sent, the VC is taken down, and then the process has to be repeated for the next datagram. The trick to using IP over an ATM network is figuring out how to keep IP datagrams that are moving between two hosts flowing through the same ATM VC.

This should all be made easier by several emerging technologies that attempt to combine the best of IP and ATM. The two attracting the most attention are IP switching and tag switching. Tag switching, developed by Cisco Systems, is brand new and has not been deployed yet. Because Cisco is such a dominant player, tag switching will almost certainly be widely used. This technology is no easy trick. IP routing involves inspecting a number of fields in each packet (at least source and destination, and perhaps a port number) and making some complex decisions about it, such as whether to filter it out, give it priority, or forward it. The processing power required to do all this gives IP routing some scalability problems. The line at the hotel desk can start backing up as patrons fill out registration cards and clerks check credit cards.

ATM, operating at Level 2, makes much simpler choices, basically just looking at the virtual circuit identifier (VCI) and forwarding the cell on the appropriate VC. That's one reason why ATM switches tend to be a lot more efficient than IP routers at high data rates. (Another reason is that ATM switching is hardware-based, while IP routing is software-based.)

However, there's a trade-off for ATM's speed: While the traffic is in the ATM network, you lose IP's decision-making intelligence. IP packets are being transferred reliably over ATM networks, in massive amounts. That's not a problem. But the ATM network lacks the intelligence to make subtle distinctions

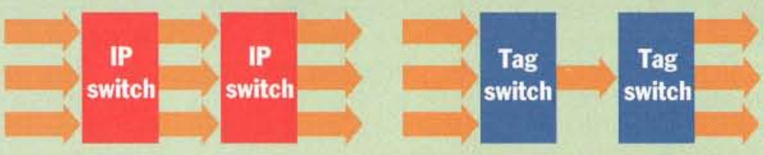
Want Better Service? Make A Reservation!

With either the IP-switching or the tag-switching approach to cooperation between IP and asynchronous transfer mode (ATM), there has to be a mechanism for users to reserve bandwidth and request service guarantees such as limits on delays. A standard is emerging for that: the Resource Reservation Protocol (RSVP). When an application needs guaranteed bandwidth or quality of service, it can request a network device, such as a switch, to reserve the necessary resources.

However, as the network starts to scale up in bandwidth and to accommodate more connections that might need reservations and quality-of-service guarantees, potential problems appear. For one thing, each RSVP reservation requires state information in each router or switch that has reserved bandwidth for the reservation. Maintaining all that state information for thousands of calls could be a huge burden on network equipment. Proponents of solutions like tag switching and IP switching are thinking about solutions to this problem, but no one knows yet what will really work.

"RSVP work is being done in the Internet Engineering Task Force," says Bob Hinden, director of routing and network management software for Ipsilon Networks. "A number of researchers and vendors are prototyping it and getting experience with it. But I don't think the industry has figured out how to put it into commercial service on a large scale."

Tag-switching technology might offer some relief for this problem—if multiple flows could be bundled up under one tag and a single reservation made for the aggregate.



Tag Switches Are More Flexible

IP switches maintain state information for each flow and do not aggregate or disaggregate flows.

Tag switches aggregate or disaggregate flows. The right-hand node maintains state information on just one flow.

IP switches must maintain state information on each flow, while tag switches can maintain less state information.

"I would use RSVP for selected flows going into an edge router," says Fred Baker, a senior software engineer with Cisco Systems. "But across the backbone I am going to set up a single reservation from that router to another edge router. Instead of having 5000 individual RSVP reservations, I am going to have one reservation that is the sum of their bandwidths. I might use the IP 'precedence' field to tag the aggregate flow, a 3-bit field, and we're done. Instead of having to maintain state information for 5000 reservations, backbone switches and routers maintain state information for one reservation. Or there might be several reservations for different classes of service. That becomes very scalable."

between different kinds of traffic. That won't do for the emerging voice/data/video Internet/intranet of tomorrow. Different types of "flows" need different amounts of bandwidth. They have different tolerances for delay and packet loss. When network traffic consists largely of such specialized flows, it will be much more important to give them the special treatment they need. In addition, IP features such as network segmentation and the ability to quell broadcast storms will become more important as traffic volume explodes.

"Years ago, the industry transitioned from bridges to routers because we wanted the higher level of intelligence to build large meshed networks," says Todd Dagres, general partner with Battery Ventures (Wellesley, MA), a venture capital firm that focuses on the communications and software industries. "If we want to go back to Layer 2 switching for better performance, then the consensus is we need to try to preserve some of the things we got from routing. Users aren't willing to throw that intelligence, control, error checking, and security away."

Hence the attraction of IP switching and tag switching, both promising but immature technologies. IP switching has been deployed, but its sales so far are minuscule. "It doesn't even show up on the map," says Dagres. Not on the sales map, perhaps. But it's there on the mindshare map. Everyone is claiming they have it or will have it soon. By the year 2000, according to Dagres, IP switching will be integrated into a variety of high-performance routers, ATM switches, and Gigabit Ethernet products and will hold 15 percent of that combined market.

Don't Fight, Just Switch

IP switching is basically IP routing intelligence controlling ATM switching (or potentially some other Layer 2 technology that offers multiplexing). The result is a device that can route or switch, depending on the traffic characteristics. Thus, IP switching complements rather than competes with ATM.

The basic function of IP switching is to identify flows (or extended IP conversations). More precisely, a flow is a sequence of IP packets sent from a particular source to a particular destination and sharing the same protocol type (such as UDP or TCP), type of service, and other characteristics. The user can configure how many packets it takes before the IP switch controller says, "Aha! A flow!"

The IP switch controller is an add-on processor to an ATM switch, essentially a router with the switch. It can use ATM as the Layer 2 protocol, but it retains IP at Layer 3. For instance, it may be a Pentium PC running routing software. Once the IP switch controller has identified a flow, it asks the upstream node (from which the flow is coming) to label the flow with a new virtual circuit identifier. Then the traffic starts to flow into the ATM switch on a new VC. Independently, the downstream node can ask the IP switch controller to set up an outgoing VC for the flow—meaning that the downstream node also recognizes this as a flow. Once the flow is isolated to particular incoming and outgoing VCs, the IP switch controller instructs the ATM switch to make the

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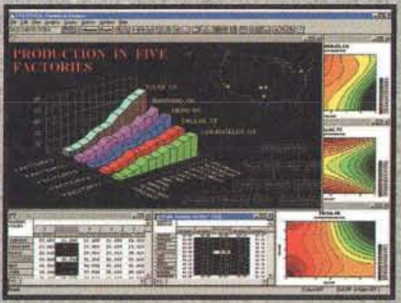

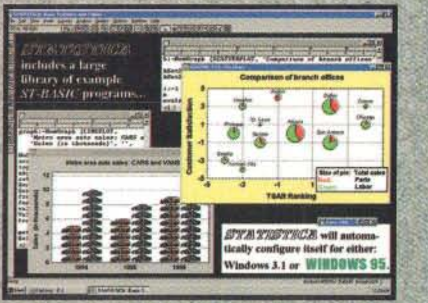
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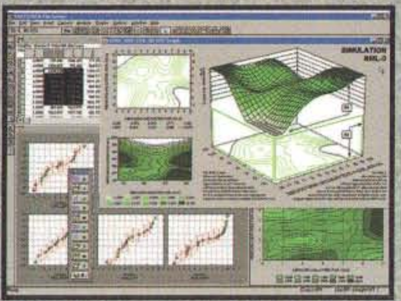

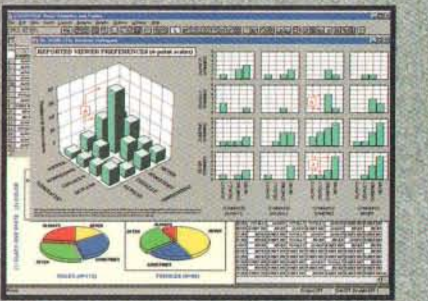

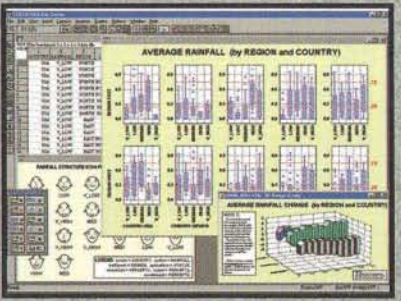
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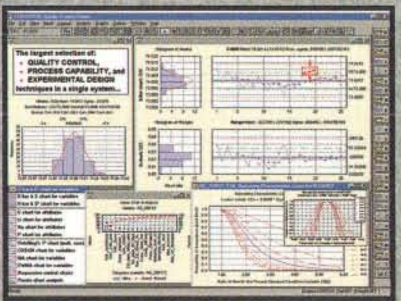
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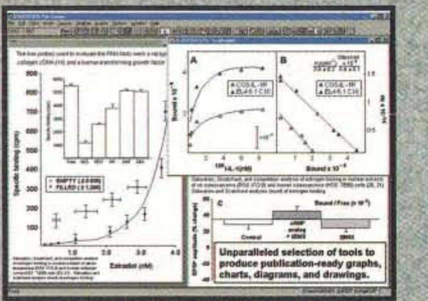
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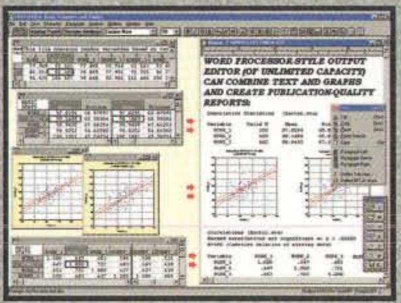
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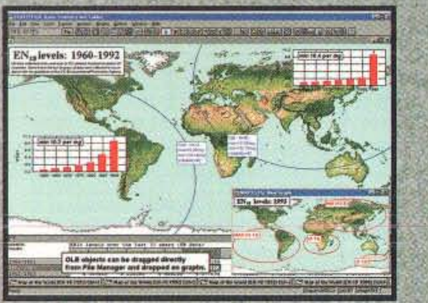

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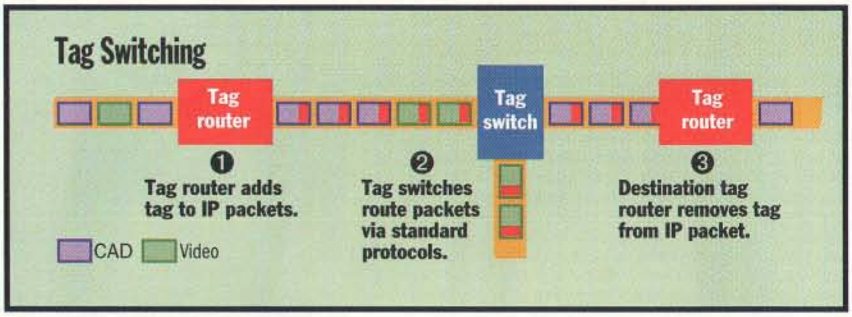
Tag Switching
Tag router
Tag switch
Tag router
❶ Tag router adds tag to IP packets.
❷ Tag switches route packets via standard protocols.
❸ Destination tag router removes tag from IP packet.
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In a tag-switched network, IP traffic is appended with tags that tell ATM switches how to handle that traffic.

appropriate port mapping in hardware, thus bypassing the routing software and its associated processing overhead. Thus, by mutual agreement, IP switches form a "bucket brigade," switching packets as fast as the ATM hardware can carry them. Only the first IP switch in line continues to examine IP header information. The rest of the IP switches look only at VCIs—a much quicker operation.

Any packets that are not part of a recognized flow (about 20 percent of the bits on the network, according to Ipsilon Networks, inventor of IP switching technology) are simply routed by the controller to the appropriate port on the switch and sent to the next switch. There the process is repeated.

IP switches, because of the superior performance they can offer, will replace some backbone routers. IP switching will also enhance ATM "edge switches" that combine multiple traffic streams into a single ATM pipe. IP switching will allow the edge switch to make intelligent routing decisions for different traffic streams rather than just dump traffic into fixed VCs. On private networks, IP switches will also be used in backbones and as edge devices. In addition, they'll provide broadband access to Internet service providers (ISPs). As an access device, an IP switch could, for instance, dump digital voice channels from a T-1 into fixed VCs while providing intelligent routing, security, and manageability for IP traffic. And finally, traffic can cross public ATM nets that have a virtual path service and still retain the VCIs assigned the private portion of the network; on the other side of the cloud, the switches can once again intelligently handle flows.

Vendors of ATM and frame relay switches, integrated WAN access hubs, and routers will all get into the IP switching game, says Dagres. In a typical ISP today, for instance, you might see an Ascend MAX WAN access hub, a Cascade 9000 frame relay switch, and a Cisco 7500 router, says Dagres. By the year 2000, that ISP might have an IP switch that combines the functionality of all three products, or perhaps just the functionality of the router and the frame relay switch. If the ISP has moved up to ATM to connect its points of presence, the ISP might be using an IP switch that's the equivalent of today's Cisco router combined with an ATM switch from FORE Systems (Warrendale, PA).

IP switching is an immature technology today. A good many of its problems may be addressed by the year 2000. For instance, vendors might have developed a way of providing an equivalent for the end-to-end quality-of-service features of ATM. In addition, despite the IP switch's focus on bilateral flows, perhaps some means of setting up virtual LANs can be worked out. We will almost certainly have IP switching standards by that time—something that's entirely lacking now.

A final problem with IP switching today is that it doesn't do anything for bursts of data too short to be identified as flows, and it may do unnecessary work for flows that are just barely long enough to be identified as flows but don't go on much past that point. Perhaps IP switches will learn to optimize performance by dynamically adjusting the flow-recognition threshold (the minimum number of packets it takes to be recognized as a flow).

Tag Along

The IP switch eliminates the need for a separate router. Not surprisingly perhaps, Cisco, whose routers handle about 80 percent of the Internet's backbone traffic, has

May I Speak to the Manager?

Reserving bandwidth and quality of service is a great capability, but if it were an everyday occurrence that we depended on to make voice and video calls, we'd also run into a series of management and security problems.

On the management side, the big problem is arbitrating between multiple reservation requests. After all, the Resource Reservation Protocol (RSVP) doesn't create bandwidth, it only helps us allocate what's there. In addition, because of the costs of maintaining state information, it may not be possible or advisable to grant every reservation request, even if the bandwidth is available.

Requests could be quite complex and numerous, especially if users start employing agents to make the reservations for them automatically, according to rules that the individual user sets up. It's not impossible to imagine two or more agents attempting to do mutually contradictory things, one of them making a lot of reservations and the others unmaking them just as fast.

"The network has to have some way to protect itself from 'agent wars,'" says Patricia Seybold, president of the Patricia Seybold Group (Boston), a consulting firm specializing in emerging technologies. "Because we'll be in the thick of it by the year 2000."

The most likely approach may be a "policy manager," based on Simple Network Management Protocol (SNMP), that arbitrates between reservation requests. "We'd like to put an object in an RSVP message that uniquely identifies a flow and the owner of a flow—somebody to bill to and look up in a policy table," says Cisco senior software engineer Fred Baker. "A router could send an 'inform' or 'acknowledge' trap to a network management host saying, 'I have received a reservation request.' The management station could request some more information from the router and then come back and use an SNMP 'set' to either say, 'The policy manager says that's a really wonderful reservation,' or else 'No. Remove that reservation and install this other one instead.'

"That's not out there right now. In general, the SNMP 'set' is not used today because of security issues. Most routers are read-only, for instance, due to authentication problems."

"We're working on solutions," Baker says, "and by the year 2000 I expect they'll be out there, so that we can use the 'set' capability in SNMP more."

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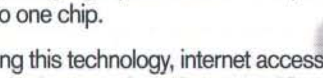

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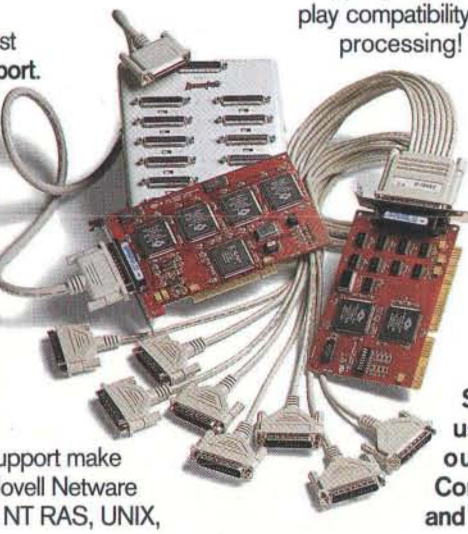

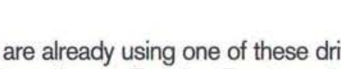

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developed a router-based alternative to IP switching: tag switching.

A tag is basically a handy label for an IP route. Although there are fundamental architectural differences between tag switching and IP switching, from the user's perspective they'll accomplish pretty much the same thing initially; that is, they'll both push traditional routing out to the periphery of the network, leaving pure ATM switching on the backbone.

How IP Routing Compares with ATM

ATM	IP Routing
Inflexible packet-forwarding decisions	Highly flexible packet-forwarding decisions
Primarily a backbone and WAN technology	Universally supported
Fast	Slower
Highly scalable	Less scalable

Cisco claims tag switching is more scalable than IP switching because multiple flows can be identified with a single tag. Each flow within the aggregate flow can have its own tag, too. Moreover, the process is recursive: Aggregates can be aggregated, and the "superaggregate" identified with a single tag. This allows the tag switch (e.g., a router with tag-switching capability) to perform a multiplexing function. When a combined flow reaches the demultiplexing tag switch, the tag switch strips off the aggregate tag and routes the subflows based on their individual tags. This lends scalability to the tag-switching architecture—backbone routers between the multiplexing and the demultiplexing routers don't have to know about all those subflow tags. (Maintaining state information on lots of tags is tiring for a busy router.)

The Bit Boom

Bandwidth crisis? What crisis?

"There is not a basic capacity problem," says Vinton Cerf, senior vice president of data architecture at MCI Communications. For instance, the underlying fiber-optic network that carries MCI's voice, Internet, and other data traffic operates at speeds ranging from 2.4 terabits per second to 3.75 terabits per second, and it will soon be 10 terabits, says Cerf.

That's Layer 1—probably a thousand times more potential than we will know what to do with, even in the year 2000.

At Layer 2, the highest-speed wide-area service, Synchronous Optical Network (SONET), is running today at up to 4.96 Gbps. More typical rates are 155 Mbps and 622 Mbps. A typical rate of 10 Gbps on SONET by the year 2000 is a conservative extrapolation from the achievements of the last few years.

By itself, SONET can be used only for point-to-point links. A few businesses with really huge volumes of traffic do use SONET point-to-point from their premises to the central office. Phone companies are aggressively pushing this alternative. For instance, if you'll commit to spending $20,000 a month on telephone service, MCI will build you your very own 155-Mbps SONET link to the Internet for free. (That should make the Web pages fly!)

Businesses that don't have the phone bills to justify SONET will, for the most part, probably continue to use asynchronous transfer mode (ATM) over digital circuits such as T-3 (45 Mbps). No revolutionary changes there—just a steady evolution toward higher bandwidths and more ATM.

In contrast, each flow has to have its own VC all the way through an IP-switching network. In general, flows can't be aggregated because IP switching doesn't provide any way to disaggregate them. Since some state information has to be maintained for each active flow, this architecture is less scalable than tag switching, according to Yakov Rekhter, a technical leader at Cisco. It would be easy to define an aggregation/disaggregation scheme for IP switching, but what you'd end up with would be tag switching, says Rekhter.

On the other hand, the whole idea behind IP switching is that there is very low overhead associated with a flow once it's handed over to the ATM hardware. That's what makes it more efficient than traditional routing. It's not clear to what extent maintaining state information is actually a bottleneck for IP switches.

When we look back from the year 2000, these arguments might sound like medieval discussions about how many angels can dance on the head of a pin. The big picture may turn out to be convergence of high-performance routers with IP switches.

"Just as switch vendors are adding routing functions through IP switching," says Dagres, "router vendors are adding switch features like high speeds, lower cost, simplified administration, and quality of service. The IP switch market will evolve out of both the ATM switch and the router markets."

Perhaps IP switching and tag switching could even work together. "IP switching has a very strong emphasis on individual flows," says Rekhter. "Tag switching has individual flows as a special case."

Whichever technology managers adopt, they'll be happy to know that the combination of ATM and IP is already working well in a very demanding setting: MCI's Internet backbone. According to Vinton Cerf, senior vice president of data architecture at MCI Communications, "MCI is running IP on its 622-megabit ATM backbone right now. It works fine. The key is enough buffer space in the ATM switch to insure that it won't drop any packets."

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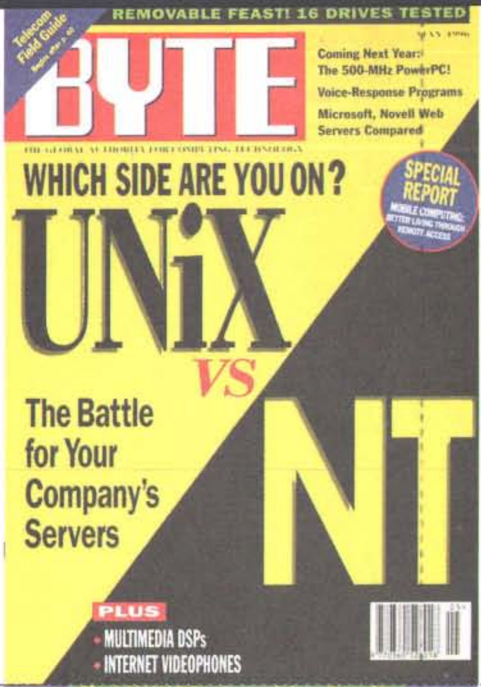
That's significantly faster than most corporate backbones, and it points up issues that will have to be tackled as the century turns. Says Cerf, "I am concerned that conventional routing may not work fast enough when we're running 1.2 gigabits or 10 gigabits in the backbone. You start to run out of gas in terms of how many packets you can pump through. That's why ATM will be challenged by IP switches during the next two to three years. And router and switch vendors of all kinds, I hope, are under some pressure now to deliver products that will actually work at high speeds." B

Michael Hurwicz (**mhurwicz@attmail.com**) *is a writer who specializes in networking.*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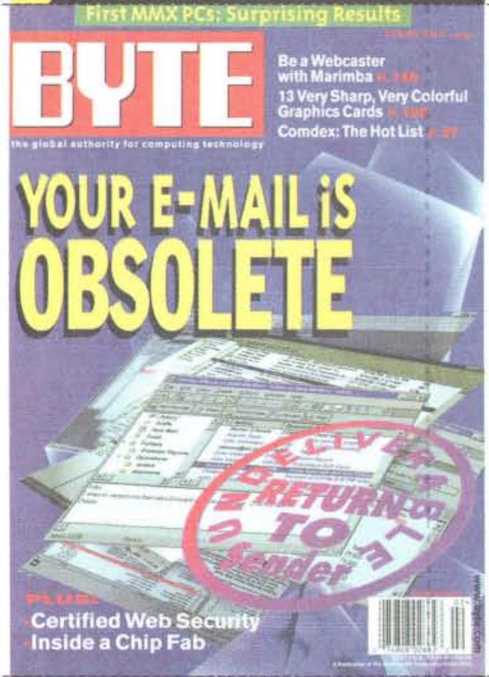
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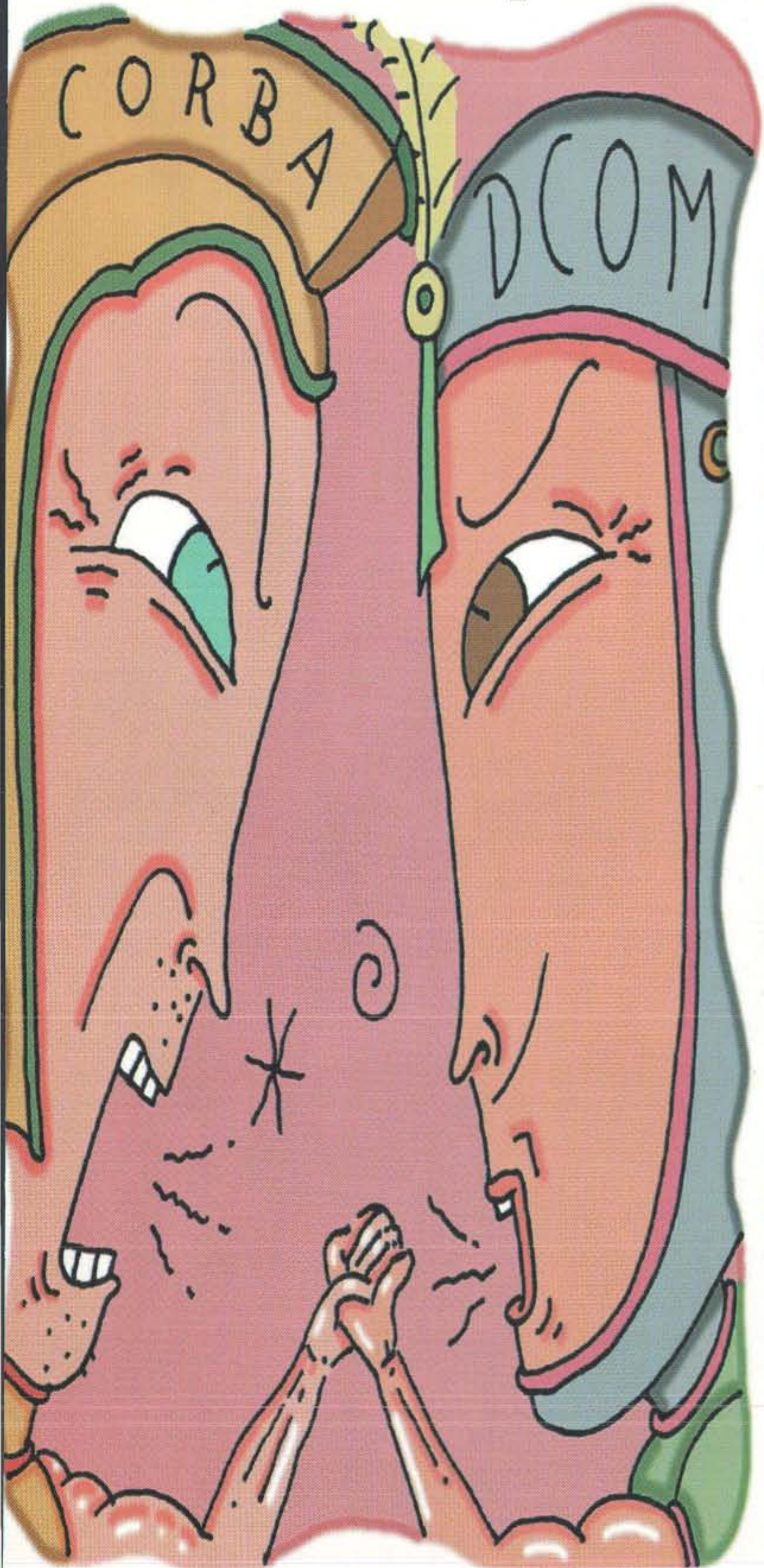

CORBA and DCOM are supposed to make network programming easier. Which one's right for you?

Distributing Components

Enough with the philosophical arguments. It's time to get practical with CORBA and DCOM.

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Let's Talk

Two leading technical approaches for getting COM and CORBA to communicate with each other.

Page 99

Programming with CORBA and DCOM

Our test application shows it isn't as easy as either side would have you believe.

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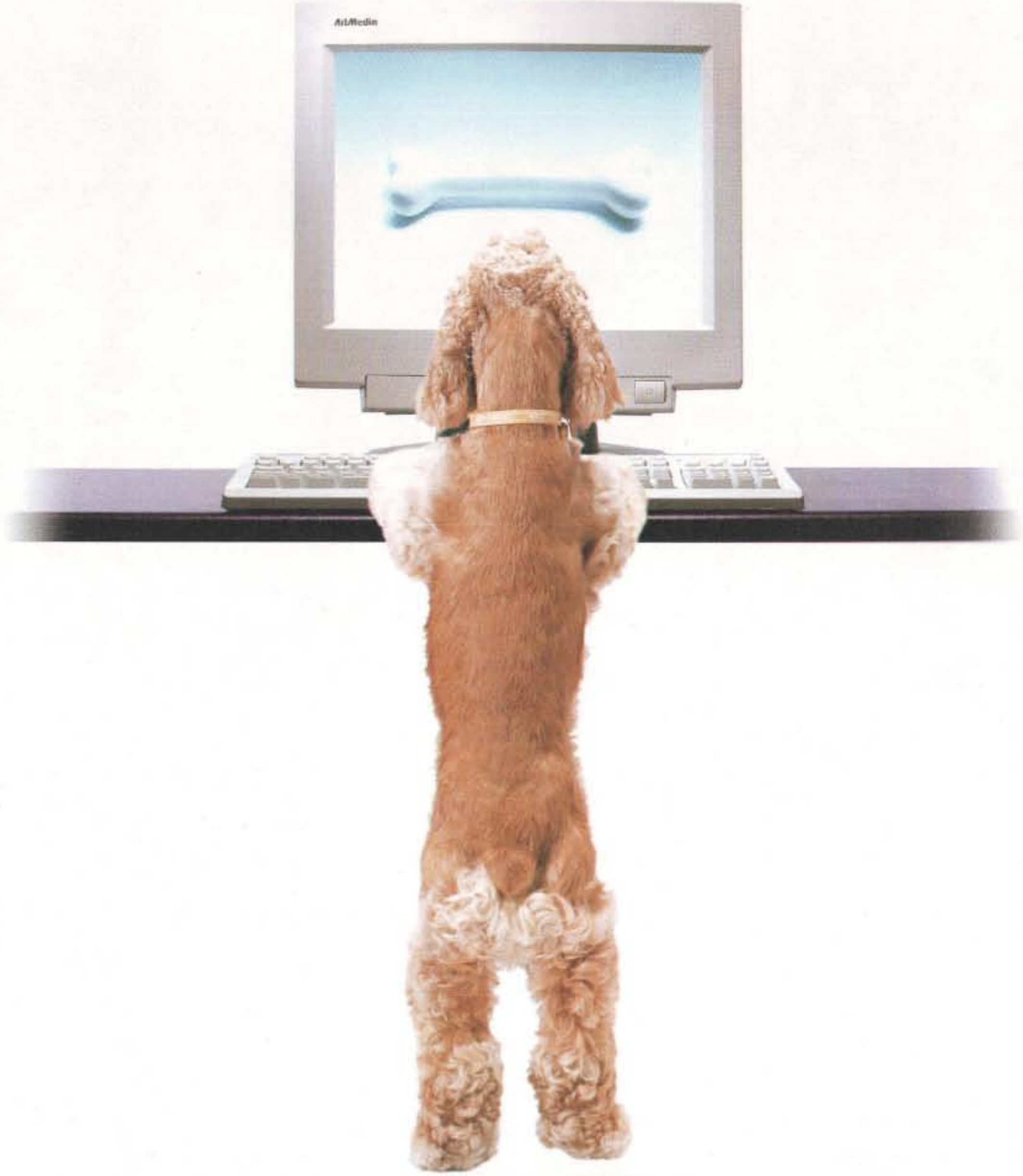

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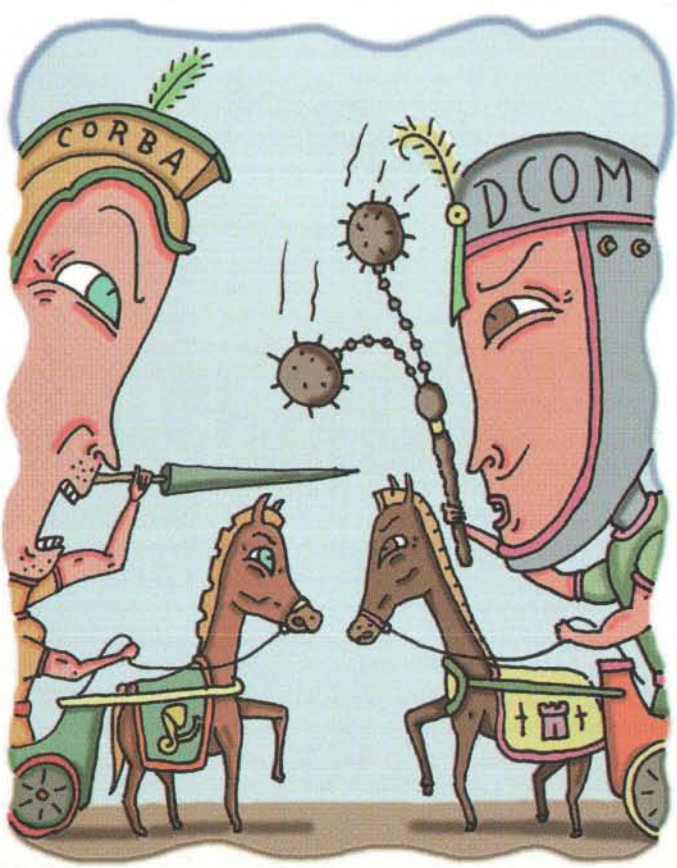
Distributing Components

For CORBA and DCOM it's time to get practical.

By John Montgomery

The Web has made a kind of client/server computing ubiquitous—we don't even think about it any more. A click on an HTML page can activate any variety of programs on a server transparently. Now that we have come to depend on it, we need to be able to do more than run canned Perl scripts and executables. We need a richer environment to take us to the next level—where client and server can pass dynamic data back and forth.



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You could use remote procedure calls or a proprietary solution connecting your objects, but why reinvent the wheel? The Object Management Group's Common Object Request Broker Architecture (CORBA) and Microsoft's Distributed Common Object Model (DCOM) are both standards that can handle much of the plumbing for you. They have also become warring sects in a vicious religious war for technical dominance. Highly technical discussions of type versioning and reference counting pervade newsgroups and lead to bitter resentment on both sides. And you're in the middle, trying to make a decision about which platform to base your next project on.

The traditional logic has said something like, "Use CORBA whenever you need to talk to a non-Windows platform; use DCOM for Windows-only systems." But things have changed. Microsoft turned the management of DCOM over to the Open Group and introduced the Transaction Server as part of its Active Platform. In addition, German giant Software AG is porting DCOM to many non-Windows platforms. So much for CORBA proponents' assertions about DCOM's openness and scalability. Similarly, the incredible popularity of Java, and Netscape's incorporation of an Internet Interoperable ORB Protocol (IIOP, pronounced "eye-op") ORB in its browser, are countering some of Active Platform's statements about the availability of CORBA ORBs. Traditional logic just fell apart.

Where once CORBA had complete dominance in cross-platform environments, DCOM is blazing its way in. Where once COM was the desktop solution, Netscape has given CORBA an inroad. Independent software vendors (ISVs) and corporate software developers both need to consider (or reconsider) their distributed component strategies. If that happens, we could see more environments that use both, through either gateways or wrappers.

Lay Down Your Weapons

The CORBA and DCOM camps alternately lance and bludgeon each other with assertions about each other's technology. In the bludgeon category are sweeping generalizations. "[DCOM] is going to be challenged in multiplatform environments," says Colin Newman, vice president of marketing at Iona, a leading ORB vendor. Possibly. But Software AG is porting DCOM to Solaris, HP-UX, MVS, and Linux (to name a few), and Digital is porting it to Digital Unix and OpenVMS. "CORBA is more mature than DCOM," says Richard Dumas, SunSoft's product manager for Neo, another CORBA implementation. "We're talking about specifications that more than 600 companies have been working on for eight years." Oh yeah? "CORBA is *not* more mature than COM," says Mark Ryland, technical evangelist at Microsoft. "In fact, COM was there first." It didn't, however, have distributed capabilities until last year.

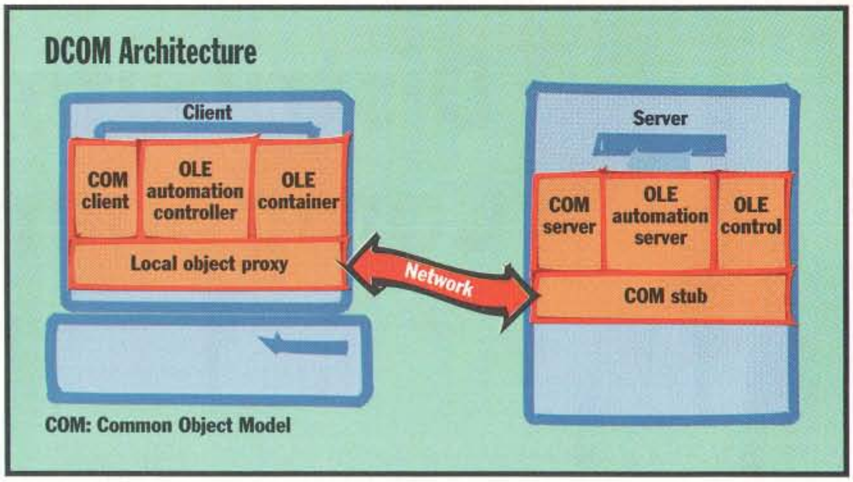
In the lance category are specific, sometimes picayune assertions about each other's technology. "CORBA doesn't support versioning of types," says Microsoft's Ryland. "Future versions of objects won't necessarily be compatible with existing interfaces." If you know that, you probably know that Microsoft's answer was an effective but Draconian method that required future versions always to support the past versions' interfaces, in effect creating multiple interfaces that can do pretty much the same thing. "Reference counting [in DCOM] is a bad way to do memory management with respect to distributed garbage collection," says Patrick Ravenel, principal software engineer of the architecture group at ORB vendor Expersoft. "Unless an application pings clients, it can't know how many outstanding references there are for its server objects." True, but according to Microsoft, the ping traffic isn't that great, and CORBA's solution isn't much better.

It seems that for every statement one camp makes, the other can respond reasonably. Going about an evaluation of CORBA and DCOM at this level simply isn't helpful. Even simple descriptions can become occluded: When we tried to write a simple explanation of how CORBA works, we inadvertently generated a small cloud of controversy. (Natural language couldn't express clearly enough how object invocation works.)

Leveling the Playing Field

"The technical nitpicking just doesn't matter," says Richard Esmond, chief technology officer and executive vice president of Diamond Head Software, an imaging system software vendor. DCOM and CORBA provide similar enough services that a debate at this level is really interesting only to a very small number of people—like the architects of the two technologies. For everyday use, the debate centers around much simpler issues, like what operating systems you need to support, what languages you want to program in, and (yes) your political feelings toward Microsoft and standards bodies.

When it comes to platform support, CORBA holds an edge. Not only can you get an ORB for every popular operating system, but for some OSes you can get two or four different vendors' ORBs. Native implementations of CORBA are available on just about every platform. You can get Digital's ObjectBroker, for example, on 20 platforms including Mac OS, AIX, MVS, OS/2 Warp, OS/400, Digital Unix, OpenVMS, HP-UX, Windows 3.x, Windows 95, and Windows NT. ObjectBroker is an extreme example of how cross-platform CORBA is, but much the same story is true for Iona's Orbix, Visigenic's VisiBroker, Expersoft's PowerBroker CORBAplus, and IBM's System Object Model (SOM). Most of these vendors are also working on Java versions of their ORBs, so expect to see CORBA on any platform that has a Java virtual machine.



Distributing COM calls for an object proxy on the client machine. The proxy passes object calls over the network to a stub on the server.

"CORBA is open," says Dan Gilfix, business product manager for Digital's ObjectBroker. But so, he continues, is DCOM. Now that Microsoft has turned management of the DCOM standard over to the Open Group, expect CORBA's total domination in multiplatform environments to come under attack. Currently released for Windows 95 and NT, DCOM will be making its way to other platforms this year. Software AG and Digital are both doing the ports. Expect general releases of DCOM for Solaris, MVS, Linux for Intel, Digital Unix, HP-UX, AIX, SCO Unix, and OpenVMS throughout the year, according to evangelist Ryland at Microsoft. This rapid port schedule should do a lot to narrow CORBA's cross-platform lead.

So which standard is more open? One of the big differences in the standards is how they're implemented. CORBA implementations work from a set of written standards. DCOM proponents say that working from a written standard means there can be incompatible interpretations of the standard—interpretations that actually lock you into a single vendor solution. DCOM implementations work from source code licensed either from Microsoft or from the Open Group. CORBA proponents say that Microsoft controls the source code so it's not really open. Further, if there's a difference between the written DCOM standard and the source code, the source code stands as correct. Both the OMG and the Open Group require implementers to pass a set of validation tests.

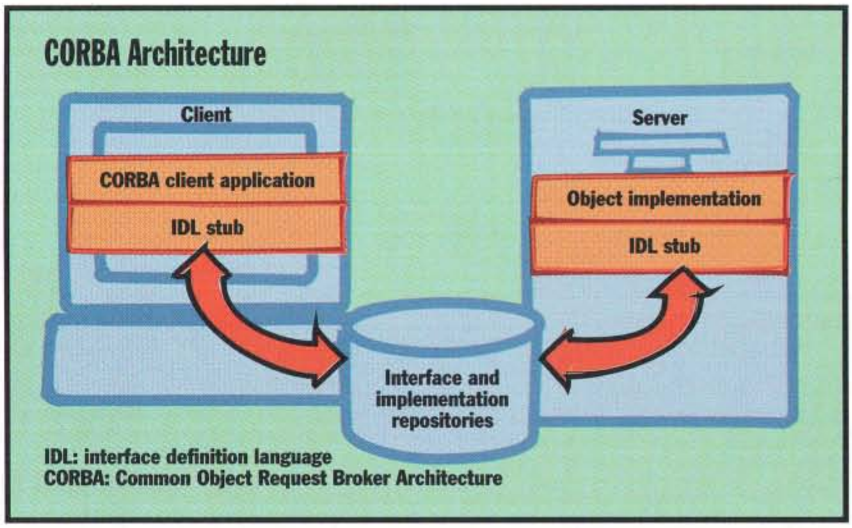
After operating system, choice of programming language is probably the largest factor that will affect your decision. Probably the clearest case is if you have a company stocked with Smalltalk programmers. Then you're going to be looking strongly at CORBA. Otherwise, it's another mess. For example, Visual Basic works with ActiveX and generally prefers DCOM. But by spending some extra time and effort, you can get tools from vendors such as HP and Iona that enable you to access CORBA objects from Visual Basic (with varying degrees of success).

IIOP and Netscape

Talk to people about DCOM and CORBA and you'll hear dozens of variations on the theme "Microsoft on the desktop, OMG on the servers." With Microsoft aggressively opening DCOM and having it ported to myriad OSes, the first part of that assertion is changing. Netscape's agreement to incorporate Visigenic's VisiBroker ORB in the Communicator browser can change the second. "The Internet is putting a lot of energy back into CORBA," says Eckart Walther, product marketing manager for Netscape's Open Network Environment (ONE).

One of the problems that confronts CORBA on an almost daily basis is that it's not ubiquitous on the desktop. Worse, with the exception of IBM's SOM, you have to pay to extend your OS with an ORB. By contrast, Microsoft has placed the seeds of COM in every copy of Windows, and DCOM will soon follow. And until 1994, there was no standard way for one vendor's ORB to talk to another's.

But in 1994, the OMG ratified the Internet Interoperable ORB Protocol. This specification, which virtually every ORB vendor claims to support (whether they really do is another matter), enables objects created with one vendor's development tools to talk to objects created with another vendor's. In other words, the ORBs have a standard protocol for talking to each other. "IIOP was meant to be the least common denominator for ORB interoperability, and it's good for that," says Expersoft's Ravenel. "However, it isn't the most efficient or highest-performing protocol that you could use. ORB-specific protocols can be made to exhibit higher performance and higher reliability, but not at the same time."


CORBA Architecture
Client
CORBA client application
IDL stub
Server
Object implementation
IDL stub
Interface and implementation repositories
IDL: interface definition language
CORBA: Common Object Request Broker Architecture

In CORBA, two repositories handle where objects are and what they do, and match client requests with server objects.

By itself, IIOP is an important standard if you are considering CORBA. On July 30, 1996, it became important to every user of Netscape's browser. Netscape and a small ORB vendor named Visigenic announced that VisiBroker for Java would become a standard part of every copy of Netscape's browser and its SuiteSpot server software. With one agreement, CORBA—or at least IIOP—became ubiquitous.

It might seem a strange marriage. After all, CORBA has traditionally been the domain of Fortune 500 companies that need solutions for integrating multiple desktop OSes with multiple server OSes and mainframes. But, when you look at it from Netscape's perspective, the requirements aren't so different. "We have to run on 17 platforms," says Netscape's Walther. "CORBA is a multiplatform integration solution. Although ActiveX is being standardized, it's the protocol [that's being standardized], not the services." (See "Will Netscape Set the Standard?," March BYTE.)

With a Java ORB inside every copy of Netscape, client applets have an efficient way to connect to server objects to invoke their services. For example, Wells Fargo Bank in San Francisco reengineered its infrastructure to use CORBA. This system integrated many of its services to be accessible from one interface. Currently, only employees of the bank can use the interface, but it's possible that a customer-oriented interface could access the ORB back end from inside a Netscape browser. Wells Fargo wouldn't have to redesign its back end at all—just write a simple new front-end applet that would talk to the Visigenic ORB in Netscape Navigator.

What's holding back such advances? First, the version of Netscape's browser with the integrated ORB (called Netscape Communicator) didn't become available in beta form until the beginning of this year. Second, and possibly more important, there's currently no standard CORBA interface definition language (IDL) mapping to Java. That means applications written to take advantage of the Visigenic VisiBroker ORB in Communicator might not necessarily be able to talk to other client-side ORBs. The OMG is working on a mapping specification; the submission to the OMG was expected to be ratified last month.

Once the IDL-to-Java mapping is ratified, you'll be able to choose from a variety of Java ORBs. Many of the ORB vendors are working on or have finished Java ports of their ORBs. Sun's Joe, for example, currently provides an IDL-to-Java mapping and a Java ORB. In theory, you could run Joe as an applet inside Netscape. Iona also has a Java version of Orbix (called OrbixWeb Java), and HP is working on a Java version of ORB+. Expect to see lots more Java ORBs when the standard is ratified. Until then, however, you might want to be a little careful about developing for one particular Java ORB.

So what can you do with a Java ORB that's special? For starters, "We're going to make LDAP [Lightweight Directory Access Protocol] available through IIOP," says Netscape's Walther. "You'll be able to register an object in the LDAP directory," making it easy to find. Also, says Walther, expect IIOP over Secure Sockets Layer (SSL) to have shipped in the first quarter of 1997, creating a secure transport for IIOP transactions.

There are still a few questions to be resolved, however. First, there's the performance question: IIOP isn't known as the fastest communication method, and Java is no speed demon itself. Is the speed of the ORB going to be a hindrance? According to Walther, performance won't be a problem—the round trip to get an acknowledgment is measured in the single-digit milliseconds. So much for that.

A second question has to do with Microsoft's Internet Explorer (IE). Microsoft has aggressively matched Netscape Navigator's feature list. So, if the ORB-browser integration thing really takes off, won't Microsoft just integrate an ORB into IE? "We have one component architecture. We have the DCOM stub which

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offers equivalent functionality already in IE," says Microsoft's Cornelius Willis, group product manager, Internet Platforms. This enables Microsoft to scale the model from components running in the browser to components on multiple servers, even scripting transactions in the Transaction Server. Willis says the big problem that Netscape is going to have is multiple component architectures: Internet Foundation Classes (IFC), JavaBeans, ActiveX, IIOP, Java remote method invocation, and LiveConnect. Having these different models is going to make it difficult to move component development knowledge across different parts of the network, from client to server.

Of course, nothing is ever that simple. Across the diversity of the Internet, the likelihood of every company supporting the same single architecture is close to zero. So while there may be an implementation difficulty, Netscape could have better support for the diversity of the Internet. The question then becomes whether a single-minded focus on one architecture from Microsoft will gain enough mind and market share to marginalize other architectures.

Although Microsoft won't integrate an ORB into IE, you'll still be able to run any ORB written in Java in it. And if you don't fancy running Java inside IE, you may even find ORBs implemented as ActiveX extensions: "We'd consider implementing IIOP as an ActiveX control," says Iona's Colin Newman.

Choose Both?

The choice between CORBA and DCOM could be too hard to make. So maybe you should choose both. If, for example, you like COM on the desktop and CORBA on the server, you can bridge them with products from many of the ORB vendors including Digital, HP, Iona, and SunSoft. Or you could wrapper one within the other.

Diamond Head produces imaging and work-flow solutions. Currently, its ImageBASIC product is based on COM, but Diamond Head is going to implement CORBA as a wrapper by the third quarter of this year. "For the longest time, we were thinking of doing the objects in CORBA and wrapping them through DCOM," says Esmond. "But CORBA was too slow. With CORBA, you have to deploy an ORB on each client plus an ORB at a server. Each machine has to be configured and tested. So you raise the bar of effort of what you have to do to get your system deployed."

But a funny thing happened on the way to the CORBA port: Microsoft released some astounding tools for network communication. First among these is the Transaction Server. Esmond says Transaction Server will give ImageBASIC a level of security and reliability that its current network transport doesn't have. In addition, Microsoft is releasing a development suite, called Visual Studio 97, that includes Visual InterDev, Visual Basic, Visual C++, Visual J++, and Visual FoxPro, and it enables you to create distributed applications easily with Wizard-like controls. "Using VBScript or JavaScript, you can script components regardless of location, regardless of source-code language," says Microsoft's Willis.

Where, What, When, Whom

If you're looking at building a distributed application, you're going to have to answer four questions: Where do you want it deployed, what language do you want to write it in, when do you need it, and whom do you trust?

Where? According to virtually everyone we talked to—even the CORBA vendors—Windows-only sites have no reason to consider CORBA right now. Similarly, shops with no Windows at all have no reason to consider developing for DCOM. Mixed marriages are somewhat more complicated. Right now, CORBA holds an edge in the cross-platform world, with more than 20 OSes supported. And Netscape's IIOP support gives you the capability to run the same applet, unchanged, on 17 platforms. But things change, and DCOM is going to come out on myriad OSes by the end of 1997 if Software AG's timetable holds. And if DCOM really becomes cross-platform, it could really hit CORBA hard because, according to Diamond Head's Esmond, "The strength of the ActiveX option is really the incredible tools that Microsoft is offering and the thousands of controls that are currently available from third-party partners."

And that brings us to the what and when questions at the same time. What language do you want to use, and when do you need your application? Few people would argue that the development tools for CORBA are superior in usability and ubiquity to Microsoft's. For many developers, C++ means Visual C++. But if you need a cross-platform application right now, you'll choose CORBA because, with the exception of Solaris and Windows, DCOM isn't soup yet.

The last question, for many, is the most fundamental: Whom do you trust? Some people despise Microsoft out of principle. "If this is a religion, Microsoft is the Antichrist," says Microsoft's Willis. Others view DCOM as a single-vendor solution and fear lock-in. Yet others sneer at the standards-making process at the Object Management Group, considering it too slow and impractical. They like the high availability and level of integration of Microsoft's tools.

There is no capital "T" truth to lead you to the correct choice. A year ago, CORBA held a decisive lead over DCOM in many areas—cross-platform support, openness, and especially networkability. But Microsoft's Active Platform strategy is narrowing the gap. So far, Active Platform's main inroads have been in Windows NT and one very popular version of Unix. But by the end of the year, that, too, could change. How comfortable are you with Microsoft? ■

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WHERE TO FIND

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(508) 493-5111
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Expersoft
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Iona
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(617) 949 9000
http://www.iona.com/

Microsoft
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Netscape
Mountain View, CA
(415) 937-2555
http://home.netscape.com

The Open Group
Cambridge, MA
(617) 621-8700
http://www.activex.org/

SunSoft
Mountain View, CA
(512) 345-2412
http://www.sun.com/solaris/neo/

Visigenic
San Mateo, CA
(415) 286-1900
http://www.visigenic.com/

Let's Talk

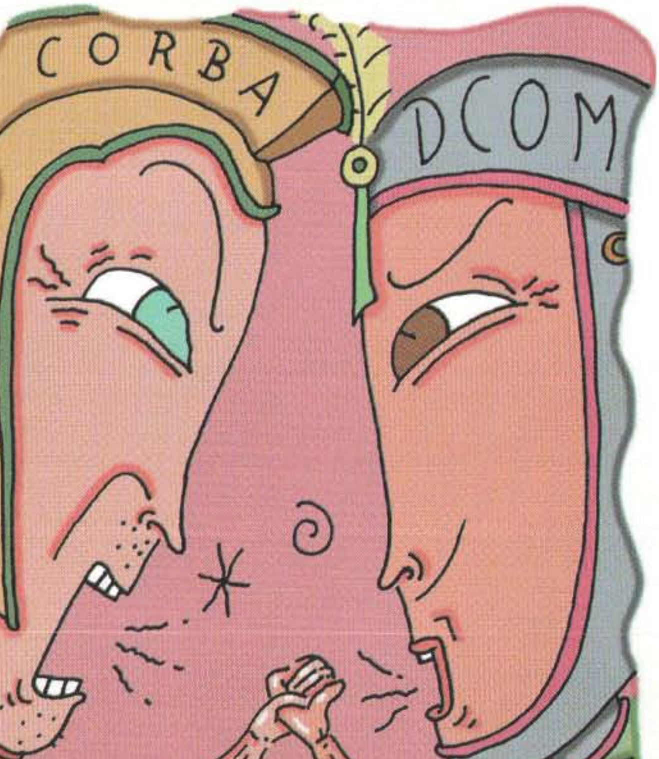
Getting COM and CORBA talking to each other requires more than just lip service.

By Mike Foody

You can sit around all day debating whether the Distributed Common Object Model (DCOM) is better than the Common Object Request Broker Architecture (CORBA). It's fun in a perverse way. But if your job is to produce real applications using these two very different component schemes, you have more practical concerns. The real question is: How do you get your DCOM and CORBA applications to talk to each other?

One answer is the Object Management Group's (OMG's) COM/CORBA Interworking Specification, a standard for interoperability between CORBA and DCOM. Products that implement this standard enable OLE and DCOM objects to be used from CORBA and vice versa. But not all forms of interworking are created equal. Some vendors merely pay lip service to interoperability while working diligently behind the scenes to snare customers into a single-vendor solution.

The key to freedom within the distributed-computing sphere is a technical understanding of the available choices and of how vendors are trying to lock you into a specific approach. Here's a look at the OMG's Interworking Specification and the two leading technical approaches to COM/CORBA interoperability.



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Four Degrees of Interoperability

Microsoft's way of doing things and the OMG's way don't line up directly with each other. In particular, COM and OLE Automation (the two most common ways to talk to components under Microsoft's scheme) have very different performance characteristics and require different levels of programming experience. Consequently, the COM/CORBA Interworking Specification has two elements. The first specifies OLE Automation–to–CORBA interoperability; the second specifies COM-to-CORBA interoperability.

OLE Automation is the portion of the OLE specification that is designed to facilitate the manipulation of objects via scripting languages. It offers a limited range of data types and is relatively low performance, but it's easy to program. COM, on the other hand, offers a complete range of data types and relatively fast performance, but it is essentially stylized C++ coding and is a more difficult programming environment in which to work. To make matters more complicated, between OLE Automation and COM is a technique that is known as *dual interfaces*, which adds high-performance COM method-calling to OLE Automation but still restricts the range of data types you can use.

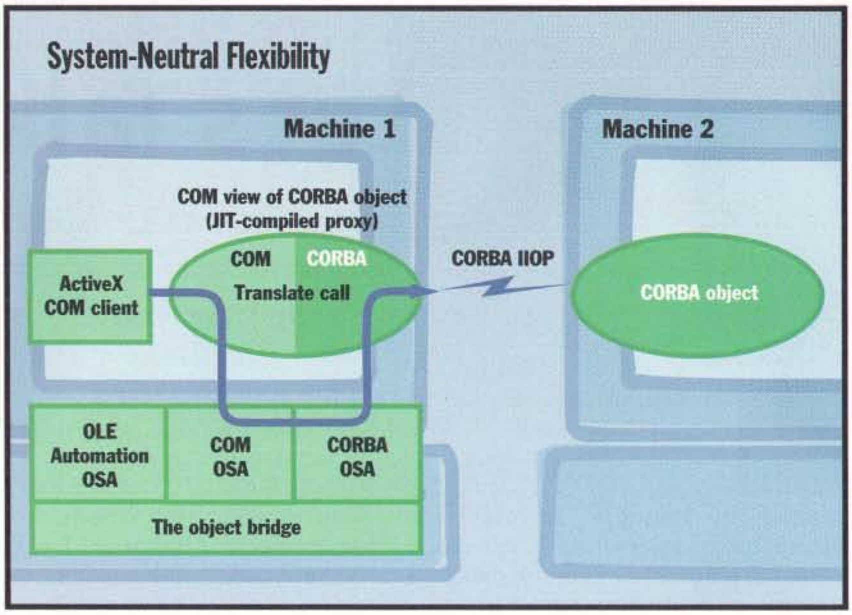
Different interoperability solutions implement different degrees of interoperability. For example, some schemes, such as the one offered by Visigenic, support only OLE Automation–to–CORBA interoperability. Consequently, they provide limited capabilities and relatively poor performance.

The performance of the dual-interface technique, used by Iona, is certainly faster than OLE Automation for local method-calling, but it, too, is slow in comparison to COM for distributed systems. That's because the dual-interface technique still restricts the range of supported data types. With dual interfaces, structures must be represented as objects, so every remote structure member accessed requires a round trip to the conversion location.

For optimal performance in distributed systems, then, you need to have full COM support. Currently, you'll find this level of support in Digital Equipment's, Hewlett-Packard's, and Sun

Microsystems' interoperability techniques.

For both OLE Automation–to–CORBA and COM-to-CORBA, the Interworking Specification outlines two levels of interoperability: *mapping* (one-way interoperability) and *interworking* (two-way interoperability). A unidirectional mapping solution makes objects in one system available to another system, but not the reverse. For example, a mapping solution might make CORBA objects available to OLE, but not OLE objects to CORBA. An interworking solution is needed if your application requires true bidirectional interoperability.



System-neutral interworking passes calls through Object System Adapters (OSAs) to translate them for both CORBA and COM.

One-Way vs. Two-Way

With interworking, don't assume that two unidirectional mappings constitute a bidirectional one. They don't. There are two reasons for this: First, the mapping is asymmetrical, and second, classes frequently pass or return objects in methods and properties. One-way tools, and even two one-way tools used in combination, can't handle either of these cases.

The asymmetry of the COM-to-CORBA mapping occurs partly because COM and CORBA have different techniques for accomplishing similar goals. For example, OLE has `SafeArrays`, while CORBA has `Arrays`. Also, in COM, leading underscores are common in method names, but they are illegal in CORBA. And COM has two kinds of string types, while CORBA has only one. Finally, in COM, the method ordering is significant, while in CORBA it isn't.

So why are asymmetries difficult to handle? Suppose you have two one-way tools and want to deal with an OLE object that has a method name with a leading underscore. When the first tool maps it to CORBA, it strips out the underscore. If the second one-way tool blindly maps the class back to OLE, the underscore will still be gone. In other words, it won't be the same class you started with, so none of your existing code will work with the object that was returned from a call to CORBA.

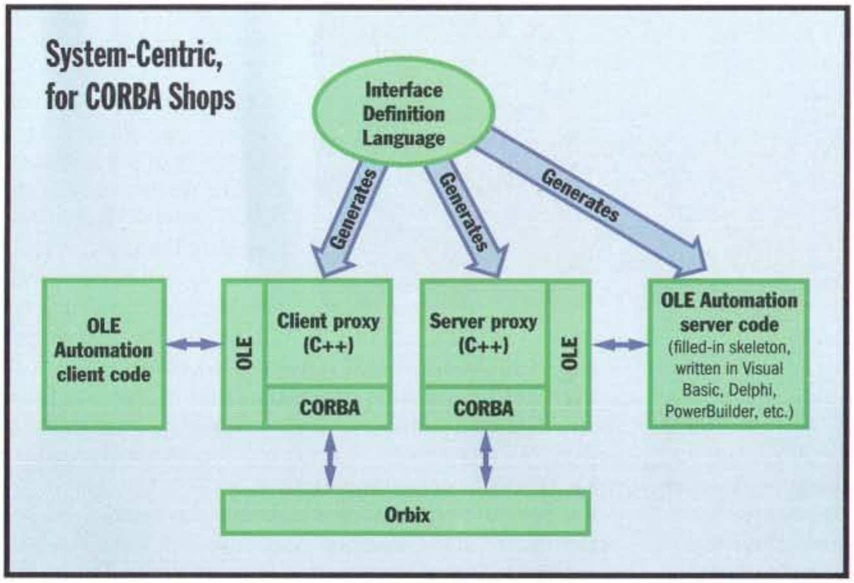
Interoperability Approaches

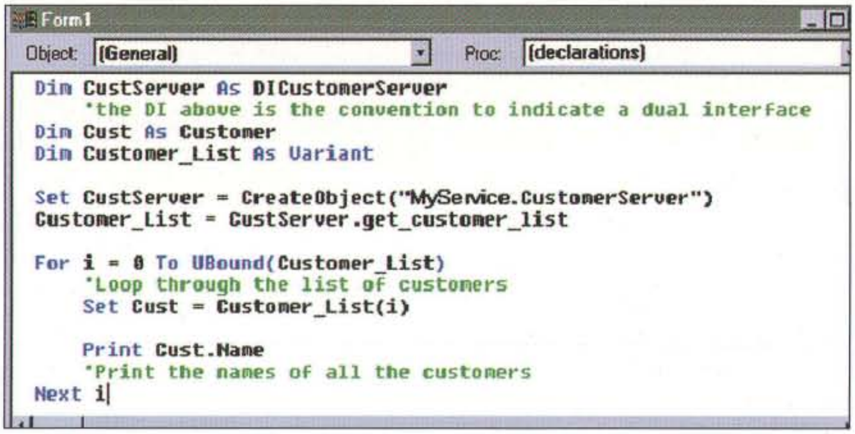
There are two main approaches to true interworking: system-neutral and system-centric. With a system-neutral approach, any existing class or persistent object from CORBA can be installed into OLE and vice versa. Once installed, the class or object appears to be natively implemented in the foreign system. A system-centric approach, meanwhile, enables developers to use a single programming paradigm. Currently, only CORBA vendors do this; you can't program in the OLE model. Before passing judgment, it's important to take a closer look at how these two approaches work.

System-neutral. Digital's Object Broker, HP's ORB Plus CORBA Connect, and Sun's NEO are all system-neutral examples. This approach enables developers to select any existing class in one of the two environments and make it available in the other. When a developer selects a class for use in the other environment, the interworking product examines the description of the class and then generates a just-in-time (JIT) compiled proxy based on that description.

Each object system—OLE Automation,

The Orbix/Desktop paradigm is fundamentally different from system-neutral examples, starting with the IDL.





Object: (General)

Proc: (declarations)

```
Dim CustServer As DICustomerServer
     'the DI above is the convention to indicate a dual interface
Dim Cust As Customer
Dim Customer_List As Variant

Set CustServer = CreateObject("MyService.CustomerServer")
Customer_List = CustServer.get_customer_list

For i = 0 To UBound(Customer_List)
     'Loop through the list of customers
     Set Cust = Customer_List(i)

     Print Cust.Name
     'Print the names of all the customers
Next i
```

This is what the Visual Basic code looks like for accessing the CORBA object in a system-neutral approach.

COM, and CORBA—has a corresponding Object System Adapter (OSA) (see the figure "System-Neutral Flexibility" on page 100). When a call passes from one object system to another, the interworking product uses the two corresponding OSAs to perform a single-step conversion. The OSA acts as a compiler front end; it's responsible for reading the native-format description of the class and passing that description to the JIT back end. The OSA is also responsible for managing issues such as proxy loop detection, mapping reference counting, and garbage collection across object systems.

System-centric. Iona's Orbix/Desktop for Windows and Visigenic's VisiBroker are both system-centric examples. This approach enables CORBA developers to use a style they're familiar with yet code their servers and clients in OLE Automation–based tools, such as Visual Basic (VB) and Delphi. (Of course, it requires VB and Delphi developers to follow the CORBA development paradigm.)

Developers follow the normal development paradigm for the ORB environment—that is, they begin with the CORBA interface definition language (IDL) and generate all the necessary skeleton and stub code. The IDL also generates C++ conversion code to map the developer's new OLE Automation class into CORBA. Likewise, the IDL generates C++ conversion code so that a client can use the server as an OLE Automation class.

Thus, if the developers have existing OLE Automation objects, they can use them (albeit with significant limitations) by taking the object's Type library and generating IDL. Once they have the IDL, they generate the necessary client and server proxy code as before.

Neutral vs. Centric: Examples

Both of these solutions can solve most problems. Ultimately, however, the system-centric approach can't do as much as the system-neutral one.

First, consider how you would access a CORBA server from VB. The two approaches are able to do much the same thing in a similar fashion. For this article, I'll use HP's ORB Plus CORBA Connect as an example of a system-neutral product and Iona's Orbix/Desktop as an example of a system-centric product.

Using CORBA Connect, assume that the object is already installed in the CORBA Naming Service. To make the ORB Plus class available in OLE, you first find the desired classes using the CORBA Connect GUI object browser (see the screen below). When you select a method of the CORBA object, you see its VB (or other) declaration. Next, group the selected classes together into a service, choose the service, and expose it to both OLE Automation and COM.

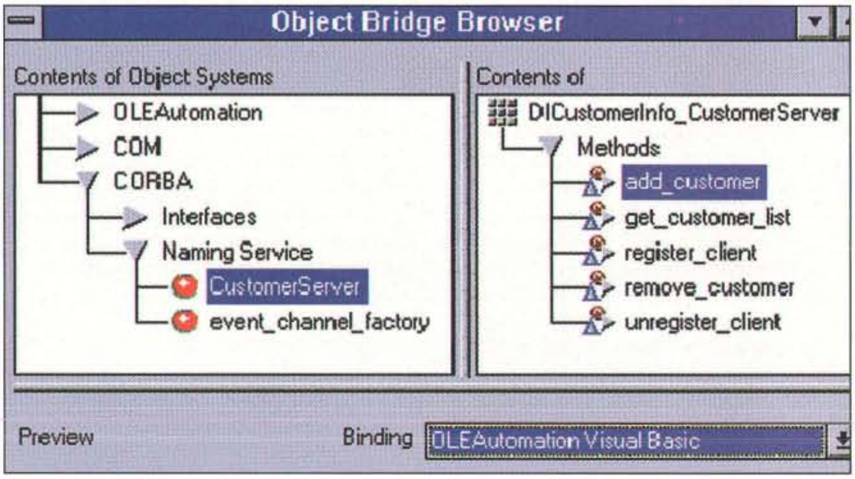
In addition, you need to generate bindings for the particular programming environment you're using by making a simple dialog-box selection. Since you're using VB, you have to generate a Type library for optimal performance. The code shown in the screen at left is in a style familiar to VB programmers. Note that the CORBA `Sequence` returned from the method `get_customer_list` has been converted to an OLE `SafeArray` so that you can easily loop through the `Customer_List`. For deployment, CORBA Connect also generates installation scripts.

Here's a look at doing the same operation with Iona's Orbix/Desktop, a system-centric product (see the figure "System-Centric, for CORBA Shops" on page 100). Again, to make things simple, assume that the `Customer_Server` object is already installed in the Orbix Naming Service.

First, you must make the Orbix class available in VB. To do that, use the Orbix OLE Wizard to select the desired IDL file. After you have selected the options you want, you generate the C++ client proxy code and compile it. Now you just register it with OLE, and you're ready to use the object from VB. The VB code to use the class is similar to that used with the system-neutral approach, although it contains more CORBA-isms.

continued

ORB Plus CORBA Connect's user interface lets you select the CORBA classes that it makes available to programming tools.



Binding: OLEAutomation Visual Basic

For this second scenario, assume you need to access an OLE server from a CORBA client—specifically, plugging some stock-quote data into Excel and graphing it. With the system-neutral approach (HP's ORB Plus CORBA Connect), you select the desired Excel classes in the GUI Object Browser and specify that they should be installed in CORBA. Next, generate an IDL binding so that the class can be used from C++. From the IDL binding, you generate C++ client stubs the way you would with any ORB Plus class. To the CORBA programmer, it appears as if Excel were actually implemented in CORBA.

Now try to do that with Iona's Orbix/Desktop. You can't. Because Orbix is system-centric, it generates all code from a CORBA IDL base. In other words, it's not designed to handle asymmetries in the OLE-to-CORBA mapping, such as `Variants`, `Unions`, `SafeArrays`, and so forth. Nor does it handle properties of type `object`.

How Two Solutions Stack Up

Features checklist	ORB Plus CORBA Connect	Orbix/Desktop
Supports OLE Automation interoperability	✓	✓
Supports COM interoperability	✓	
Is a mapping solution	✓	✓
Is an interworking solution (i.e., fully bidirectional)	✓	
Handles asymmetrical mapping issues	✓	
Converts any class instance	✓	
Handles proxy explosion	✓	✓
Handles version fix-up	✓	
Provides semantic mappings	✓	
Provides ActiveX support	✓	✓

For example, to use Excel from Orbix, anywhere a `Variant`, `SafeArray`, or `object` exists, a developer must hand-code some software to fix up the difference in the IDL-to-OLE mapping versus the OLE-to-IDL mapping. If an Excel property or method uses a `Variant`, the corresponding CORBA IDL contains an `Any`. When the OLE mapping code is generated from the IDL base, it contains a `DICORBAAny`—the proper IDL-to-OLE mapping—but it won't work with Excel.

Four Other Keys to Interoperability

There's obviously more to achieving seamless interoperability than simply following the OMG's Interworking Specification. Here are four other features that should be included in your interworking solution.

Events. Both OLE and CORBA have their own standards on how to provide asynchronous event capabilities. OLE provides an event mechanism with ActiveX controls called Connection Points. CORBA provides a different event mechanism, called Event Channels. To ensure seamless interoperability between the two, the semantics of events must be mapped across systems.

In OLE, if an ActiveX control provides a Connection Point, code can be written (in a tool such as Visual Basic [VB]) to execute when that event is triggered. In other words, when an ActiveX object triggers its event, another developer's code–in this case, the VB programmer's code–is executed.

Events are ubiquitous. But what happens when a class with an event is made available in another system? One possible solution to this problem is to map the event object classes directly from one object system to another; that is, have CORBA programmers learn the arcane semantics of OLE Connection Points and make OLE programmers learn the equally restrictive language of CORBA Event Channels.

Ideally, interoperability tools should support semantic mapping, where the semantics of OLE Connection Points are mapped into those of CORBA Event Channels. With semantic mapping, developers in both systems see only the semantics they're familiar with; there's no need to learn the intricacies of a second set of system semantics.

ActiveX controls. The COM/CORBA Interworking Specification also doesn't deal with ActiveX controls. How, for example, does an interworking product handle such ActiveX requirements as the packaging of Type libraries with the `Control` in a downloadable package?

Proxy explosion. Proxy explosion happens when an object is passed back and forth across systems and a new proxy is created each time instead of the original object being returned. In such cases, the number of proxies simply explodes. Not surprisingly, the ability to handle proxy explosion is a requirement for any production-quality system.

Version fix-up. Version fix-up is an important feature in any system that supports COM interoperability. Since COM objects have fixed `vtable` layouts, although CORBA doesn't specify or require method ordering, inserting a method into a new version of a class's CORBA IDL is likely to break any compiled COM objects. Version fix-up neatly avoids such problems by automatically placing the new methods at the end of the existing COM `vtable`.

Choosing an Approach

As the above examples illustrate, both the system-neutral and the system-centric approaches can handle some interworking. And in CORBA-centric shops that develop servers in C++ and clients in VB, a CORBA-centric approach might fit the bill nicely. Such shops must organize development so that their server developers do all the C++ compilation and their VB programmers receive some level of CORBA training, but on the whole, a system-centric approach should work just fine. However, if you need better interoperability (e.g., you want to access OLE servers from CORBA clients) or your development is not CORBA-centric, a system-neutral approach is probably better.

The big thing to watch out for is single-vendor lock-in. Beware of marketing phrases such as "fully compliant" and "100 percent compliant" with the OMG's COM/CORBA Interworking Specification. There is a significant amount of variance in the level of interoperability capabilities and commitment to compliance. Ask questions about the examples I've given, and see how vendors respond. The answers could be enlightening.

Mike Foody is president of Visual Edge (Saint-Laurent, Quebec, Canada). You can reach him at **mike@vedge.com.**

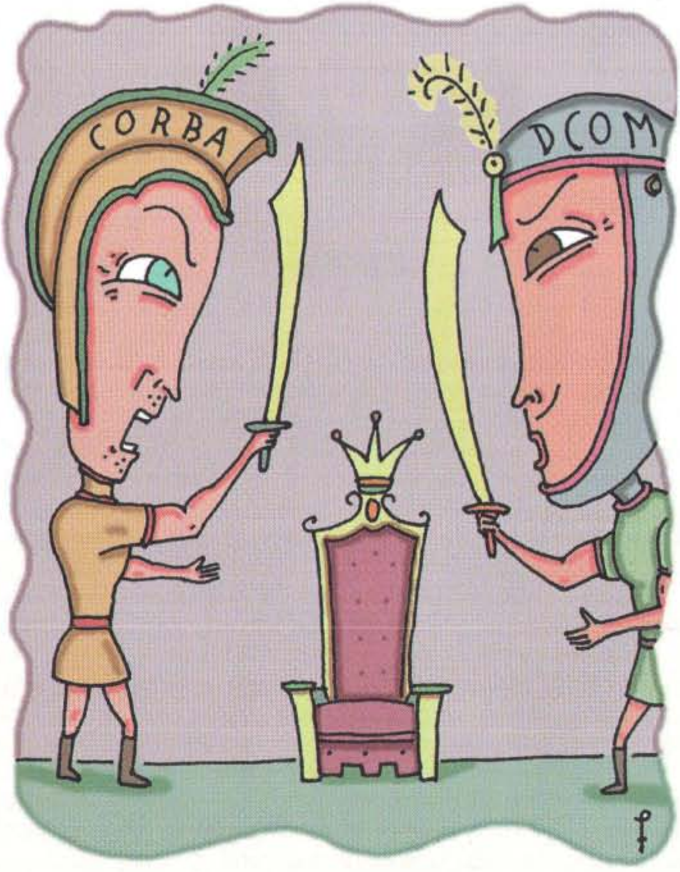
Programming with CORBA and DCOM

It just isn't as easy as proponents of either side would have you believe.

By John Pompeii

You've heard the talking heads, seen the developers' presentations. But what's it really like to program an application using Distributed Common Object Model (DCOM) or Common Object Request Broker Architecture (CORBA)? To find out, we built the same application using both. On the DCOM side we used Microsoft's Win32 Toolkit; to make the CORBA portion, we chose Iona's Orbix. The application was a simple locking service—a tool to lock and unlock a given resource.

We won't keep you in suspense. Put simply, neither CORBA nor DCOM alone provides what you'll need to build enterprise-level application servers. These two acronyms represent plumbing, and real applications need more than that—they need services like naming, event notification, and transactions. The addition of Microsoft's Transaction Server to our project would have added much of what we needed. Similarly, the CORBA services provide for these capabilities. But no ORB we know of implements all of them. In short, neither DCOM nor CORBA is a slam-dunk solution by itself.



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Create the Server

Let's dive in and see how our sample application stresses these two standards. First, we'll create the servers in CORBA and DCOM. The big differences we're going to see are in how each one handles nonunique class names and errors.

We'll start with the CORBA version. The program listing "CORBA IDL Definition" (see page 104) shows the interface of our lock service. It defines an enumeration and the class LockService. Note that there are three method declarations, each of which specifies the various input arguments and return values. CORBA defines a finite set of primitive data types used for argument passing and structure definitions. For the most part, CORBA interface definition language (IDL) files are similar in syntax to the C language (including preprocessor directives), but they deal strictly with interface-related details.

Though simple, the IDL of the ILocking COM interface and LockService class (see "DCOM IDL Definition" on page 105) highlights two of the primary differences between COM and CORBA: structure and naming. A COM object consists of one or more categories of interfaces, where each one is named and has its own derivation hierarchy. A CORBA object follows a standard object model in that its interface is defined by its class and all the ancestors of that class. In the COM interface definition, the developer provides a universal identifier (UUID) that uniquely identifies the interface and class definitions. The UUID identifies classes instead of a class name so that you can have multiple classes with the same name but different vendors and functionality. CORBA, on the other hand, uses a naming system that includes the class name and an optional module name. Module names are equivalent to the C++ namespace concept, where class names can be scoped (assigned) to a particular module. The COM approach guarantees that a collision could not occur, but the CORBA version would allow a program to use two or more classes of the same name if their module scopes are different.

Now that we have the IDL, we need to compile it. The CORBA IDL compiler generates the client proxy class and all the code for marshaling arguments. After compilation, you have three C++ classes: a proxy class, an implementation class, and a factory class. Client applications use the proxy class (we called it LockService). Derived from the LockService class, the implementation class (we named it LockService i) provides the implementation of the service. Finally, clients use the factory class to create instances of objects.

COM defines a number of interfaces that programmers need to implement, but to build new interfaces requires an IDL definition like the one in "DCOM IDL Definition," which you then compile with Microsoft's IDL compiler (called MIDL). This compiler generates the interface vtable definition, the marshaling information, and the proxy/stub DLL for clients.

CORBA IDL Definition

```
//
// CORBA IDL interface definition of the Locking Service
enum LockMode
{ReadMode,WriteMode};

interface LockService
{ exception LockServiceEx
{ long error; long location; };
boolean LockObject(in string objID, in LockMode mode)
 raises (LockServiceEx);
void UnlockObject(in string ObjID, in LockMode mode)
 raises (LockServiceEx);
void UnlockAll(in string ObjID) raises (LockServiceEx);
};
```

One of the fundamental differences between COM and CORBA is the way they handle error conditions and the amount of information that can be returned. In short, CORBA does a better job. With COM, all methods return an HRESULT integer value that indicates the success or failure of the call. This integer value in fact is split up into a number of bit fields that allow the programmer to specify context, facility, severity, and error codes. CORBA implementations, on the other hand, provide an exception mechanism that returns errors as a structure embedded within another object called the Environment. A standard SystemException structure is defined for system-level and communications errors that can occur during a remote method call. For objects such as our LockService, an exception structure can be defined that allows the server to return as much information as it wants to describe the exception. Furthermore, since CORBA is generally implemented with an object-oriented language, the exception systems of CORBA and the language can be tied together. Thus in C++, an error that occurs on the server will result in an exception being thrown on the client.

The error-handling example highlights the point that CORBA is better at supporting distributed systems. Though CORBA promotes the aspect of location transparency, the reality that object implementations exist in other processes and the complications that can result from this are exposed in the way errors are handled. Not having to care about whether an object is local or remote is a nice concept, but when a method call fails because of a communications problem or a server failure, suddenly the programmer will want to care about where that object exists. CORBA reports system errors separate from application-level errors, which makes it easier for the developer to build appropriate exception-handling code.

Let's turn to the DCOM implementation. As in the case of the Orbix factory class, a DCOM class must provide a classfactory object that implements the IClassFactory interface to provide clients a way to create instances. In addition, we define the actual LockService class that implements the IUnknown and ILocking interfaces.

The COM version of the service requires you to implement the IUnknown methods, which create a simple reference-tracking mechanism. When an object is created, its reference count is 1. When an additional proxy connects to that object, it must invoke the AddRef method to record the reference. As references are dropped, the client must call the Release method. When the reference count goes to 0, the object can delete itself. This all works if clients behave themselves and network errors don't occur that cause the client and server to be abnormally disconnected. In our server, we have implemented this scheme, but in practice, given the ease at which this could break, it probably wouldn't be too useful.

CORBA does not attempt to track the number of clients communicating with a particular object. If a client releases the object on the server while another is using it, the object will be destroyed and an error will return to the other client on the next method call. Thus, it is up to the object implementation to provide life-cycle management if such behavior is unacceptable. Without a transaction manager integrated into the distributed system, it is very difficult to implement a reliable life-cycle management system.

To complete the servers, we have to compile and link both implementations. For our CORBA server, we need to code a small main module that initializes the server and registers it with a daemon process that implements the CORBA location and activation services. The daemon process keeps track of all the running servers on the host and will start servers upon request of a client. In addition to the service implementation code, we also compile the stub and dispatching code generated from the IDL compiler into this executable.

For DCOM, we must build a server executable along with a proxy/stub DLL that implements marshaling for the LockService class. The MIDL compiler generates all the code needed for this DLL. We are left to register the DLL in the NT registry. For the DCOM server, we also need to write an additional bit of code to initialize the COM run-time environment and register the class. When initializing the COM environment, it is possible to specify a threading mode called free threading. In previous releases of OLE, the thread capable of creating COM objects defined an apartment (a separate process space) associated with each object. When a client invoked a method on the object, it was dispatched in the thread that was used to create the object, thus eliminating the need for COM objects to provide their own synchronization code. In the free-threading model, a method could be dispatched on any thread that's initialized with the free-

DCOM IDL Definition

```
[ object, uuid(7ACC12C3-C4BB-101A-BB6E-0000C09A6549),
  pointer_default(unique) ]
interface ILocking : IUnknown
{ import "unknwn.idl";
  typedef enum tagLockMode
  { ReadMode, WriteMode } LockMode;
 HRESULT LockObject( [in] BSTR szObjID, [in] LockMode mode,
                                        [out] boolean*result);
 HRESULT UnlockObject( [in] BSTR szObjID,
                       [in] LockMode mode );
 HRESULT UnlockAll( [in] BSTR szObjID );
};

[ uuid(7ACC12C4-C4BB-101A-BB6E-0000C09A6549), ]
coclass LockService
{ [default] interface ILocking;
};
```

threading option. Free threading requires the object to provide synchronization, but it can significantly improve the performance of the server. In the current version of OLE (on NT), a server could use the single-apartment model, free threading, or a combination of both. (In the Orbix server, the programmer has the option of a single-thread model or a multithread model that is similar to free threading.)

As in the case with the CORBA server, we built the DCOM server as an executable program. To support automatic activation, the program can include the additional code to allow it to run as an NT service. To enable the server, we must install the IDs for the LockService class and ILocking interface into the registry along with the name of the server executable and autostart options. You register the application either with a REGEDIT script or with code in the server.

The Client

Let's turn now to the client programs that use these servers. The sample client for CORBA establishes a pointer to a LockService proxy using the _bind method created for the LockService class. Once bound, the client can invoke methods on the proxy object just as any other C++ object. In our example, we make a call to the server to lock the object in write mode using the account number as the object identifier. Once locked, another client instance trying to get a lock would fail. Given a successful return, the program modifies the object and then invokes the UnlockObject method to release the lock.

The equivalent client program for DCOM can take the name of the server from the command line or the registry. It initializes the primary thread for free threading using the CoInitialize call, which enables the calling thread to use OLE. To get a pointer to the lock service we used CoCreateInstanceEx and can specify the class, the interface (or interfaces), and an optional server designation we want. The name of the server is not specified—its location comes from the registry.

The CoCreateInstanceEx call is a helper function that first calls CoGetClassObject to obtain a proxy to the class object for the requested class. It then invokes the CreateInstance method on the proxy to create the remote object. Before leaving, CoCreateInstanceEx releases the class object by calling the Release method on the proxy.

A successful return gives a pointer to the ILocking interface, which is then used to invoke the LockObject and UnlockObject methods. At this point, there isn't much difference between the DCOM and Orbix implementations except for how errors are handled and that the string arguments for DCOM are Unicode.

The Final Word

What does all this code tell us? It tells us CORBA is well suited for use by object-oriented languages. The code is much cleaner because the bindings fully exploit the features of the host language. DCOM, on the other hand, has done nothing to provide management classes for the method arguments or a way to link error conditions to the C++ exception mechanism. CORBA also has a superior mechanism for handling arrays and sequences and provides an "any" data type for marshaling arguments whose type you don't know in advance. For object-oriented languages such as C++, the DCOM interface is cumbersome and requires more low-level code than necessary. On the other hand, you can use DCOM—without any special gateway software—directly from popular, nonobject-oriented languages such as Visual Basic.

If your client is Visual Basic or Delphi, or if you are familiar with custom interfaces in COM, then DCOM is the right choice when it becomes available on Windows 95 later this year. For those dealing with object-oriented languages and significant object models, the CORBA model is more of a natural fit. COM's inability to support polymorphism and framework development imposes real problems for those people developing distributed object models.

The reality, though, is that neither CORBA nor DCOM alone provides what is necessary to build enterprise-level application servers. In addition, enterprise-server programming needs object services such as naming, event notification, transactions, concurrency control, and life-cycle control. For the CORBA environments, you can get some of these object services in an ORB that implements the CORBAServices specifications. For DCOM, many of these services are on the way. The most significant is the new Microsoft Transaction Server, which could provide the necessary recovery we need to make our lock service run error free. Transaction Server provides transactional integrity to changes made on COM objects and is built entirely on DCOM. For now, keep in mind that neither DCOM nor CORBA alone is a complete solution for network programming. B

John Pompeii is president of Secant Technologies (Beachwood, OH), a software engineering company that specializes in distributed systems and object-oriented tools. You can reach him at **jpompeii@secant.com.**

The complete source code of our example listings is available at http://www.byte.com/ or at http://www.secant.com/pubs.html.

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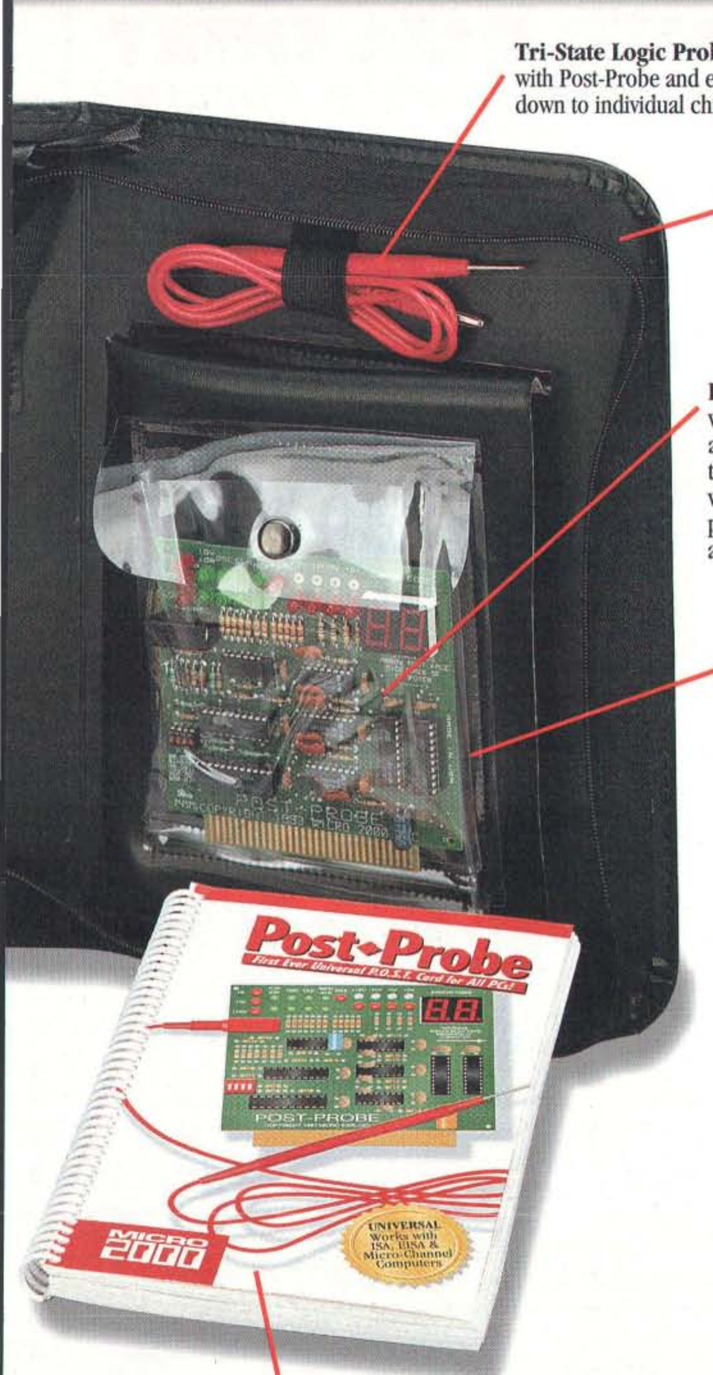

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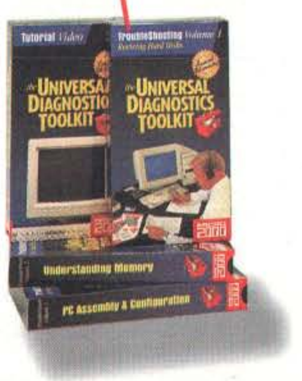
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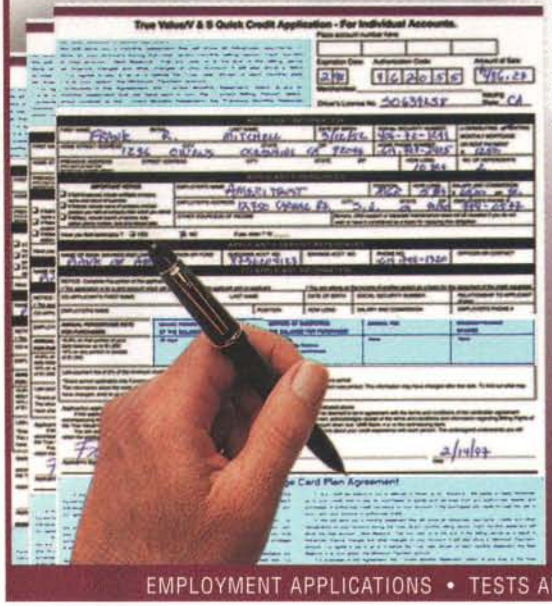
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RDBMSes Get a Make-Over

Are technologies such as DataBlades solutions or bandages for complex data management?

By Jay-Louise Weldon

Relational database management systems (RDBMSes) are the lifeblood of most corporate data centers. You can use an RDBMS to retrieve data by unique key fields and by linking fields between related records. Type in "Retrieve all employees who live in New York with managers who live in Connecticut" and your RDBMS will snap-to like a military cadet.

But the world is changing. As computers spread into wider application areas, RDBMSes can go crazy trying to handle complex data types such as images, documents, time-series inputs, or 3-D coordinates, which need special binary encodings to represent data. Data representation is only part of the challenge. Processing methods also vary among complex data types. A time series needs a start date and a calendar that specifies the intervals between observations, while processing methods for video and audio objects, for example, require play and rewind capabilities. In essence, complex data types are best represented as objects. They encapsulate the details of data, structures, and methods regarding how the object interacts with other objects.

ILLUSTRATION: LARRY MCENTIRE © 1997

To be effective, RDBMS technology must support all traditional relational functions as well as data objects. Said another way: RDBMSes must embrace some characteristics of object-oriented database management systems (OODBMSes) to become object-relational database management systems (ORDBMSes).

The major DBMS vendors, including IBM, Informix, Oracle, and Sybase, have delivered or are about to deliver technologies that push RDBMS technology into the world of objects. But the question arises: Are these bolt-on fixes that you can trust for the long term? Or should you wait for a new generation of DBMSes built from the ground up to handle complex data types? We'll explore these questions in this article and in the one that follows. Here, we will look at the capabilities of current ORDBMS technologies; "How to Improve RDBMSes" (see page 115) will peer into the future of DBMS design.

Object Advantages

With the exception of binary codes, all data processed by computers is complex data. Normally we think of characters and numbers (either integer or real) as basic data types since most DBMSes and programming languages recognize and handle them. Using a data type known to the DBMS or language frees programmers from managing the details of storing and processing the data. For example, when using numbers declared as real (often stored as a sign, a base value, and an exponent value), a programmer can specify numeric calculations (TAX = REVENUE * RATE) and rely on the DBMS or program code to properly handle the component parts of the factors and create and store the components of the result.

ORDBMSes support all the traditional relational functions as well as supporting data types other than the usual characters and numbers. Thus ORDBMSes are attractive because they let applications and processing styles that have traditionally used proprietary data management techniques become an integral part of the enterprise database. This offers the possibility of consistently managing heterogeneous business objects across multiple platforms, and it promises a common interface for managing all types of data. The result: simplified user requests and application code.

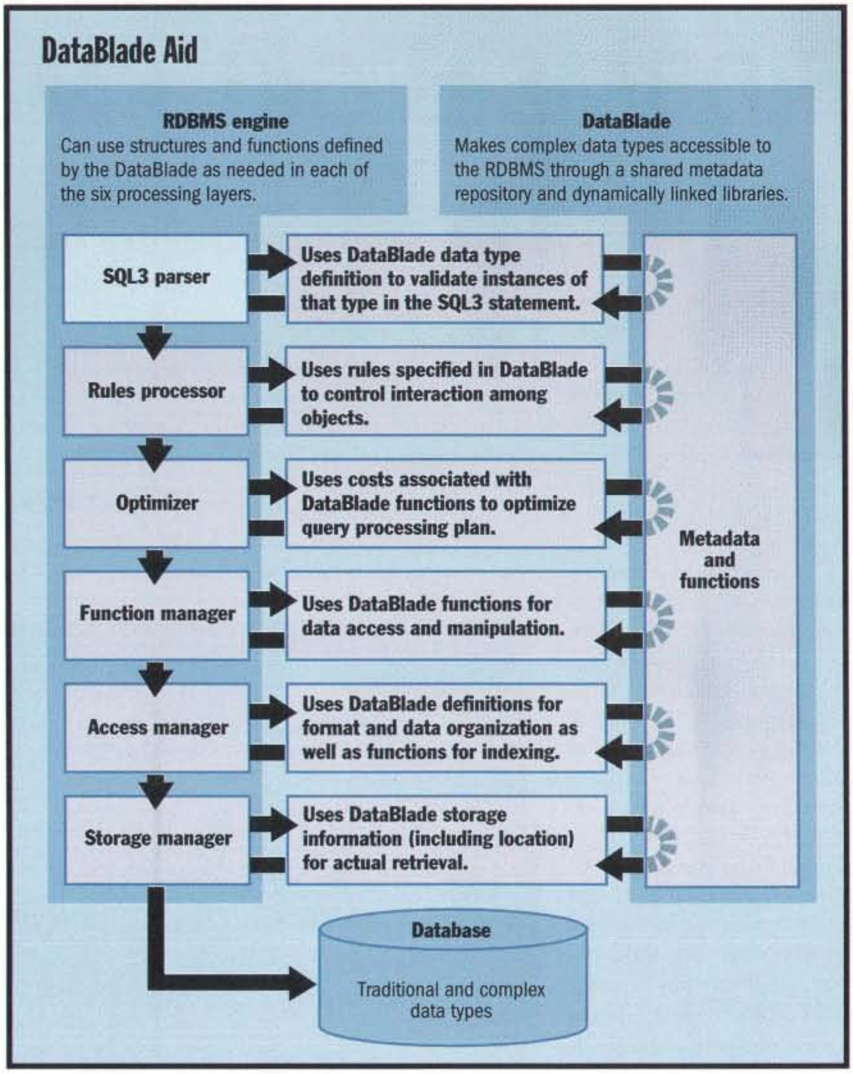
As business users increasingly recognize the value of managing collections of heterogeneous data objects, ORDBMSes may become an essential part of DBMSes. The big challenge now is extending the capabilities of existing RDBMSes to become object-aware.

continued

There are three capabilities RDBMSes must have in order to efficiently handle complex data types and objects. First, they must have storage and indexing techniques customized to each data structure. For example, methods that understand the structure of a fingerprint data type will be able to store, retrieve, and query it more efficiently than those that treat it as a binary large object (BLOB).

Second, content-based retrieval requires special methods. Image, audio, and video data will need the equivalent of text search engines that now manage documents (see "Opening Doors to Complex Data" on page 112).

Third, to deliver peak performance for search and retrieval of complex data, query optimization and the retrieval process itself must be customized to the type of data being retrieved. The cost—in terms of system resources—of complex queries for retrieving CAD/CAM designs is quite different from that for retrieving selected rows from a relational table. This cost difference increases in importance if the data objects you're searching for exist in a distributed computing environment.


DataBlade Aid
RDBMS engine
Can use structures and functions defined by the DataBlade as needed in each of the six processing layers.
DataBlade
Makes complex data types accessible to the RDBMS through a shared metadata repository and dynamically linked libraries.
SQL3 parser
Uses DataBlade data type definition to validate instances of that type in the SQL3 statement.
Rules processor
Uses rules specified in DataBlade to control interaction among objects.
Optimizer
Uses costs associated with DataBlade functions to optimize query processing plan.
Function manager
Uses DataBlade functions for data access and manipulation.
Access manager
Uses DataBlade definitions for format and data organization as well as functions for indexing.
Storage manager
Uses DataBlade storage information (including location) for actual retrieval.
Metadata and functions
Database
Traditional and complex data types

The Informix RDBMS can call data structures and functions within the DataBlade to handle complex data at various processing stages.

Creating a DataBlade

While each of the DBMS vendors is tackling these issues, Informix has the best-known answer, thanks to the publicity surrounding its purchase of the Illustra ORDBMS. This technology uses DataBlades—application-focused collections of data structures and code—to implement complex data types and objects into an extended relational database environment.

To add a new data type to a relational database, you must create both data structures and functions. The data structures must include the external representation and the internal format of the new data type. The external representation describes how values of the new data type will be displayed and also how values of the new type will be deciphered when presented as input. The internal representation describes how these values will be maintained in memory for processing. Each new data type must be supported by code that converts its external representation to its internal representation (and vice versa) as a way of creating and presenting instances of the data object. With DataBlades, you can use any of the basic data types (integer, character, etc.) and standard constructs (arrays, sets, lists, etc.) to create new data types. You can also develop data types that are variants of preexisting ones supported by the same or a different DataBlade.

A DataBlade must also include various functions for each new data type. At a minimum it must include functions to store, retrieve, display, modify, and query instances of this new type. The storage and

More Ways to Extend RDBMSes

Informix, with its DataBlade technology, has competition in extending RDBMSes to handle complex data.

Company	Strategy
IBM	DB2 Extenders support text, images, and video; can create new data types using DB2 large binary object types. Architecturally similar to DataBlades.
Oracle	DataCartridges and a "software object bus" create and deploy complex data types. Cartridges are less tightly integrated to the RDBMS than are DataBlades.
Sybase	Uses OpenServer interface to make series of application-specific servers appear as a single SQL server.

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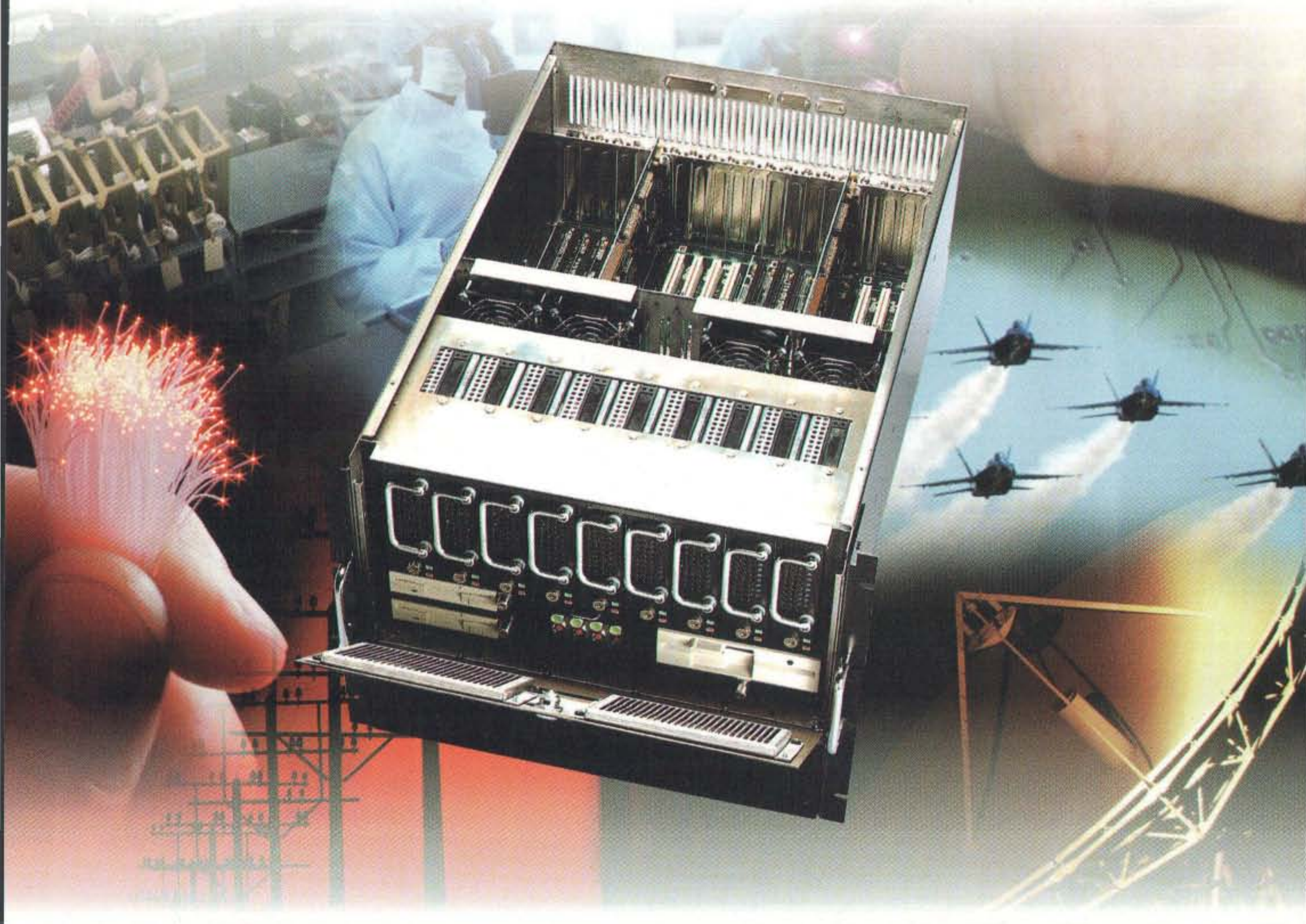

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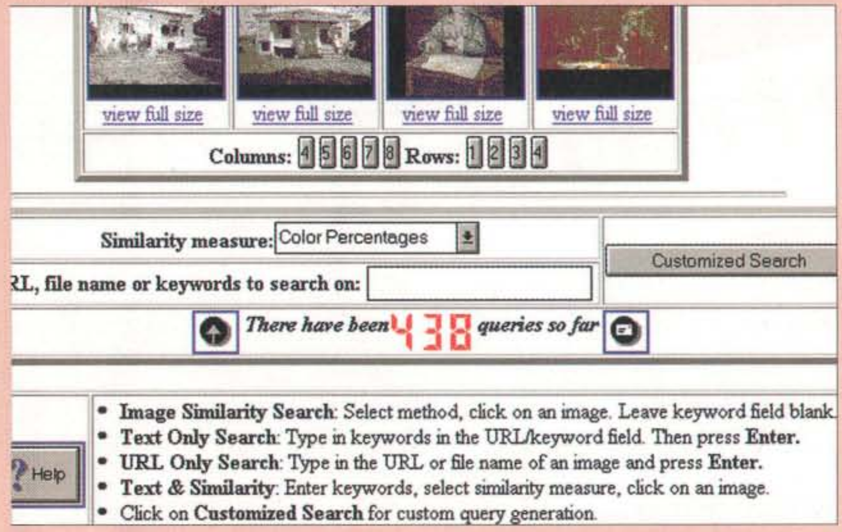
Opening Doors to Complex Data

As database vendors work to make it easier for RDBMSes to handle objects, another problem is emerging: How to efficiently find the image, audio, or other complex data type you need.

As the number of data objects grows, manual methods become increasingly unwieldy. Coordination of the indexing process becomes more difficult when no single authority controls all the data or indexing personnel. These issues are critical in an era when the Web is becoming an important data repository. Is there any consistent, coherent way to index unstructured data that would work on a global scale? Can we build a search engine like InfoSeek, Lycos, or AltaVista for images and sounds, for instance?

The answer to each question is yes, although there are significant limitations to search-engine technology, some inherent and some perhaps surmountable in time.



Similarity measure: Color Percentages

RL, file name or keywords to search on:

There have been 438 queries so far

- **Image Similarity Search**: Select method, click on an image. Leave keyword field blank.
- **Text Only Search**: Type in keywords in the URL/keyword field. Then press **Enter.**
- **URL Only Search**: Type in the URL or file name of an image and press **Enter.**
- **Text & Similarity**: Enter keywords, select similarity measure, click on an image.
- Click on **Customized Search** for custom query generation.

Query by Image Content (QBIC), developed by IBM, helps realtors, NASA, and others find data objects in image databases.

Manual Problems

Traditional database queries look for matches between search criteria and structured keys, the alpha, numeric, date, or time fields that point to a data record. The same approach works for unstructured data, such as images and sounds, but only if an operator enters one or more keys for each item. For instance, the operator might type in a catalog reference number, a caption, or a number of controlled-vocabulary keywords.

Manually entered keys are simple and effective for most databases, and they are still the dominant approach to indexing unstructured data. However, they do have drawbacks: Reviewing the data (e.g., looking at each image or listening to each sound) and then entering the key information is a labor-intensive and error-prone process. Depending on the nature of the data, you may need trained operators just to enter keys that are both correct and consistent. Finally, indexers have to know in advance which characteristics are important. The subject of the picture? The geographic location? The name of the photographer?

Content Queries

The alternative to the key-based query is the content-based query, which relies on the computer to examine the data object and report on its attributes, such as color, texture, or shape in an image or tonality or rhythm in an audio clip. Content-based queries have been used by NASA to scan images from satellites and by PhotoDisc to index its catalog of tens of thousands of stock digital images. NASA used IBM's Query by Image Content (QBIC) technology, while PhotoDisc used Virtual Information Retrieval, from Virage (San Mateo, CA). Both are commercial products, although they may require customization or integration for individual applications.

Probably the most intractable problem with these products is their limited ability to tell you the things about data objects that you really want to know. For instance, none can tell you the subject of an image. If you want to find images of dogs, you'll need to search your image database by color, shape, and texture. Along with canines, your search is also likely to net a lot of cats, horses, cows, and perhaps a few chairs and automobiles.

Of course, key-based search engines have much the same problem: If you search on the word "knuckles," you'll find the term has one meaning to a human anatomist, another to a shipbuilder or architect, and still another to a butcher. With structured data, you may be able to formulate a query that eliminates the meanings you don't want (e.g., knuckles+human). If you're dealing only with unstructured data, it's not possible to impose limits based on the actual content of the picture because the retrieval engine deals only with mathematical patterns of color, shape, and texture, not with semantics (that is, the meaning of the content to a human observer).

Content-Based Work-Arounds

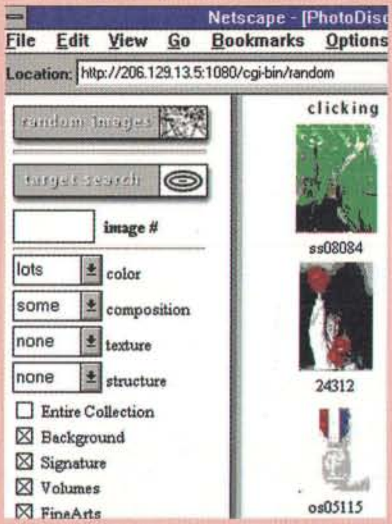
A number of techniques can make content-based querying useful despite its semantic ignorance. One approach involves multiple search cycles. The first time you search, you select an image that closely approximates what you're looking for. The search engine then compares subsequent images to that image.

Another approach uses metadata, information gathered about the image when it was captured, such as file size, time and date, type of equipment used, and so on. If you're looking for a picture of a news event that took place in 1995, it's no use searching images captured before or after that date.

Mainly for military applications, Hughes Aircraft has developed algorithms for creating "smart metadata," which does deal with the semantics of images. Historically, these techniques have been applied primarily to very small sets of data. However, improvements in algorithms and new, faster, and lower-cost hardware could make these techniques increasingly relevant for mass screenings of database images, according to Hughes. So far, however, there are no commercial applications of smart metadata techniques.

For now, the most practical approach is one that combines metadata and what could be called "manual metadata." For example, to make complex data more accessible, you might automatically record the date, file size, and resolution for each object you add to your database. You can then search for relevant attributes, such as resolution. You can hone your search by typing in a few indexing keys, such as "dog," "cat," "horse." These steps will reduce the cost of manual indexing since you can count on the automated scan to distinguish brown dogs from black dogs and probably (perhaps with a multipass search) Siamese cats from tabbies. Automated retrieval methods work much better as you narrow the field of possibilities.

In addition to making queries more efficient and accurate, these techniques also address



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lots color
some composition
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none structure
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Virage's software looks for mathematical patterns to identify images.

the problem of overwhelming the network or the querying computer with the results of the query. Another helpful technique is the creation of a "miniature" version of the data, such as a thumbnail of an image, which the operator can examine to further narrow the universe of search possibilities.

Resource Expenses

Even with all these optimizations, queries of unstructured data tend to be expensive in terms of human effort, network resources, and processing power. "The average business manager will not do it," says Robert Rose, director of product strategy for Cognos, a maker of business intelligence tools (including PowerPlay, a multidimensional data exploration tool, and Impromptu, a high-end tool for complex queries). Cognos has been tracking query-by-content technology but has not incorporated it into its products. For the vast majority of business applications, says Rose, the best strategy is still to associate a particular image with a particular report or record. Users search for the topic of the report or the key to the record (such as an employee's name) and they get the unstructured data (such as a picture of the employee) thrown into the bargain.

Rose says he has not yet seen broad-based demand for query-by-content capabilities. However, he believes such a demand may emerge as users seek some practical means to search the vast data resources of the Web. "The Web is where supply-side technology lives," says Rose.

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retrieval functions can rely on standard access methods for the base data types used by the new type, or the DataBlade can include access methods that are specific to the new type. Modify functions include any operators (such as arithmetic, string, or specialized operations) that change the value of an instance of the new type. For example, to create a lag in a time series, you might modify an existing time series by shifting back the value for each period by one or more periods. Query functions include variations of the standard comparative operations (e.g., equality, less than, greater than, like) and possibly other special functions, such as "distance" for geographic data types. The DataBlade can also contain functions that support conversion from one data type to another (called *casts*). For example, a function might convert a text document into a standard relational table consisting of a line number and a text string for each line in the document.

Each DataBlade also contains metadata on the resource cost of the various functions as applied to each complex data type. The Informix RDBMS engine uses this information to perform global optimization of queries that include several different types of data.

The DataBlade model supports the addition of objects as well. The DataBlade for an object would include its data structure (possibly a complex structure of other data types and even other objects) as well as the methods that implement the behavior of the object type. The model also can handle standard object-oriented constructs, such as inheritance and polymorphism. An object or data type can inherit properties or methods from other objects or types, and different objects or types can implement a function or an operator with the same name in different ways. For example, "distance" for geographic points can be different than "distance" for points in 3-D drawings.

Implementing DataBlades

A shared metadata repository and dynamically linked libraries of function code make the data types implemented through a DataBlade accessible to the Informix RDBMS. The RDBMS engine uses the data structures and functions defined by the DataBlade at various stages of normal processing. You can write DataBlade functions in either SQL, C, or C++ using a proprietary API to the database server kernel. Informix also plans to add support for other languages, including Java. The SQL statements CREATE TYPE and CREATE FUNCTION register DataBlade data types and functions with the Informix RDBMS server. The files containing DataBlade data and code are part of the link step when building the RDBMS server.

DataBlade functions in SQL execute like macros as part of the SQL statement processing. Functions written in C are compiled, stored as an executable, filed, and loaded dynamically during query processing, as needed. This dynamic binding insulates application code from the function implementation and allows the implementation to change without affecting the application code.

A DataBlade can also incorporate remote procedure calls that tie an external system into the DBMS. You can use this approach to integrate data stored in heterogeneous DBMSes and file systems as well as across distributed platforms.

Impact on Developers

The extensibility provided by this model can be a boon to application developers. In-house programmers can eliminate the need to manage complex data types from application code. This yields leaner code, which can be produced more quickly and can remain unchanged as the data management details change. Third-party developers offer DataBlades in specialty areas (time series, geographic data, test processing, and so on) that in-house developers can use without the need for further programming. Or, if the application demands, in-house developers can create new data types that are variants of those provided, relying on inheritance for most of the functionality.

Informix offers a foundation DataBlade with support for over 40 different data types. The company also provides a wide variety of third-party DataBlades.

The main challenges for developers are the learning curve required to understand the object-relational framework and being able to develop code within the constraints of the API. As with all object-oriented frameworks, maximum reusability relies on making good choices for basic functions, out of which more complex functions can be built. Portability across platforms is also an issue since DataBlade access methods can be very platform-specific. And lastly, the interoperability of functions and data types among different DataBlades can be problematic, especially since there are no standards within applications as yet.

Other Approaches

Informix is not the only one providing RDBMS object-relational capabilities. IBM is following a similar architectural approach with its DB2 Extenders. Extenders allow developers to create new data types that are based on existing character or numeric types or one of DB2's large binary object types. DB2 Version 2 provided support for images, text, and video using large objects. Now IBM is working with partners to develop DB2 Extenders for other key application areas.

Sybase is taking a different approach. It's developing servers for different application areas and tying them together with its OpenServer interface so that they appear to be in a single SQL Server database.

Oracle intends to support complex data types in Oracle8 using "cartridges" within its Network Computing Architecture (NCA). Oracle defines a cartridge as "a manageable object that provides extensible functionality." Cartridges will use a language-neutral interface to interact with other objects. NCA will include a "software object bus" to provide an interconnect layer linking cartridges to clients, servers, and network services.

DataCartridges will be one type of cartridge offered within NCA. Each DataCartridge will implement a specific data type, including its structure and methods for creation, search, display, etc. DataCartridges will be less tightly integrated with the RDBMS engine than are the Informix DataBlades. Oracle's approach will probably trade performance for stability. The cartridges' indirect connection to the database server will prevent disruption of RDBMS operation due to errors in cartridge code. Thus, if the cartridge is flawed, your server doesn't crash. With Informix's DataBlades, a system-wide failure may occur. However, the software interconnect in the Oracle approach may add performance overhead.

Complex Data Types

Application Area	**Data Type**
Trend analysis (financial, marketing, etc.)	Time series
Computer-aided design and manufacturing	Design renderings, blueprints
Multimedia applications	Video, audio, images
Multidimensional analysis	2-D, 3-D coordinate systems
Geographic applications	Geophysical systems (latitude, longitude, altitude)
Text processing	Document, message
Law enforcement	Fingerprints, pedigree
Chemistry/biology	Chemical structures (molecules, compounds)
Office automation	File systems (word processing, spreadsheets, diagrams, etc.), directory structures, e-mail
Intranet/Internet	Web pages

Eight Reasons Why RDBMSes Need a Make-Over

❶ Support for client/server computing
❷ Support for complex data types
❸ Global optimization of queries
❹ Improved access to special data types
❺ Support for object-oriented constructs (inheritance, polymorphism)
❻ "Wrapper" integration of heterogeneous environments
❼ Support for distributed computing middleware—Distributed Computing Environment (DCE), Common Object Request Broker Architecture (CORBA), Distributed Common Object Model (DCOM)—and management services
❽ Support for Internet/intranet applications

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The Future of ORDBMSes

Object-relational databases offer many advantages over traditional RDBMSes and OODBMSes. Most OODBMSes provide storage capabilities for persistent objects. As such, OODBMSes offer name- or key-based direct access to complex data structures. However, OODBMSes are unsuited to the types of content-based access required for query and analysis.

RDBMSes provide ideal platforms for content-based retrieval and analysis. The logical model underlying RDBMSes naturally supports referential integrity; the relational engines can also accommodate rule-based processing, such as triggers and alerts. RDBMSes have matured to encompass necessary performance and control features, such as query optimization, data security, and backup and recovery.

ORDBMSes combine the best of both breeds. They provide general access based on content as well as direct access based on unique identifiers. They also provide the ease of use and data independence that are the hallmarks of a traditional RDBMS. Through object extensions they can also provide the rich data types, reusability, and extensibility commonly associated with object-oriented applications.

Do ORDBMSes represent the future of data management? Or are they just a stepping stone to something else? I believe it is the latter. The variety of vendor solutions for extending relational database systems is a response to user requirements. In the future, the traditional boundaries between applications and computing platforms will be erased, or at least abstracted. This means we'll view and manage the environment as a whole so that an organization could, for the first time, control and gain value from all its business information regardless of form or location. Object-relational databases, at least as they are envisioned today, are just a first step in the evolution toward this goal. **B**

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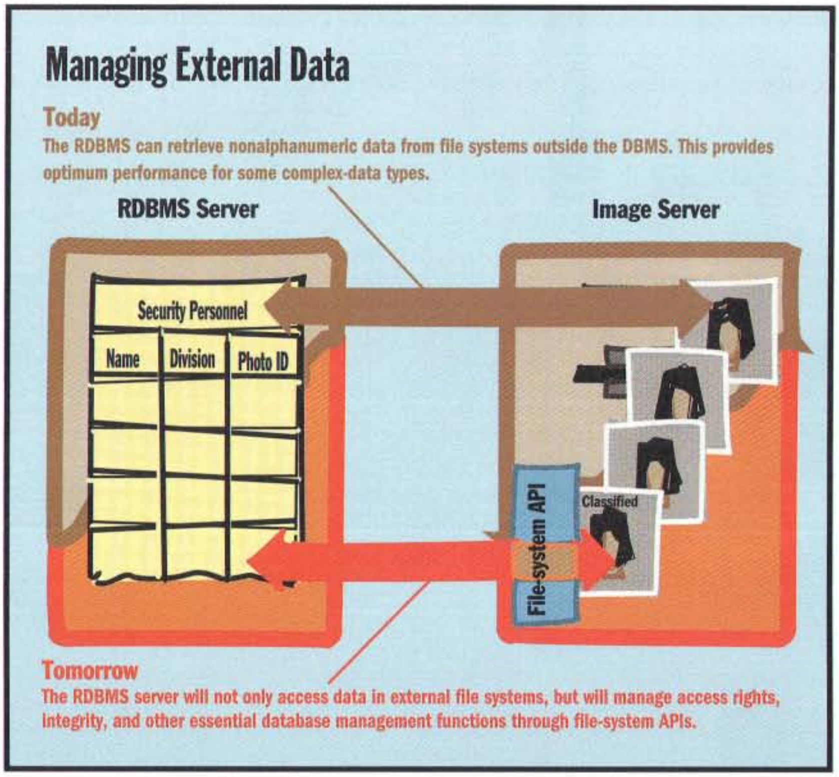
How to Improve RDBMSes

Seven long-term requirements for managing complex data.

By Nagraj Alur and Judith R. Davis



Managing External Data

Today
The RDBMS can retrieve nonalphanumeric data from file systems outside the DBMS. This provides optimum performance for some complex-data types.

Tomorrow
The RDBMS server will not only access data in external file systems, but will manage access rights, integrity, and other essential database management functions through file-system APIs.

Better management of information in external file systems is a key area where RDBMSes need to improve complex-data processing.

Every organization has its share of complex data in the form of documents, diagrams, photographs, videos, and audio files. The challenge is to find the best ways to manage and extract the information. Complex data may also be user-defined data types that are created for unique business requirements. The challenge here is creating these data types and their functions and access methods. Relational database management systems (RDBMSes) are today's guardians of mission-critical data, yet their abilities fall short for managing anything other than traditional alphanumeric data.

This is why leading RDBMS vendors are adding object extensions to their server engines by using object-relational and object-oriented DBMS technologies. We are already seeing extended data-type systems, extended language support in the server, and other object-relational features (see the text box "DBMS Vendors Weigh In" on page 116).

RDBMS vendors are also working to tightly integrate these extensions with support for symmetric multiprocessing (SMP), massively parallel processing (MPP), distributed data management (e.g., asynchronous data replication), and access to legacy data. The goal is for the extended RDBMS to handle complex data as adeptly as it does text and numbers.

Unfortunately, all the current complex-data management strategies are only partial solutions. What will we need for the long term? In addition to a full set of object extensions and robust data management capabilities, future DBMS designs must address seven key technology areas before DBMSes are truly designed from the start for complex-data types.

1. Interoperability Standards

Interoperability of object extensions across DBMSes becomes critical as we move additional application semantics into the database server. The SQL3 draft standard, which specifies the syntax of many object-relational extensions, plays a key role here. However, there still is no standard for specifying the APIs necessary to hook in other extensions. For example, language constructs should manipulate certain complex-data types, such as a time series.

As the migration to complex-data management products picks up, users will not want to rewrite code to port existing applications from one DBMS to another. If the standards don't evolve to cover interoperable object extensions, many unhappy companies will grapple with a problem like the one they faced with proprietary stored-procedure languages. (This issue is being addressed by support for additional languages on the server side with third-generation languages [3GLs], fourth-generation languages [4GLs], Visual Basic, and Java.) The need for interoperability also affects the ability of gateways to handle extensions among heterogeneous data sources.

2. External Data Integrity

Whatever database management technology arrives in the future, we'll still need to use external file systems to store certain types of data outside the DBMS. For example, video clips that are stored in a video server will provide optimal performance for delivering time-dependent data to end users. We'll want the DBMS server to not only access data stored in external file systems, but also to actively manage the security and integrity of this external data. One example of a move in this direction comes from IBM. It is developing links between DB2 and external file systems to allow the RDBMS to control data stored in the file system (see the figure "Managing External Data").

3. Multiplatform Support

The need for complex-data support won't be relegated only to certain departments, workers, or computing hardware in organizations. Tomorrow's DBMSes must extend complex-data processing from high-end, multiprocessor platforms, such as data-warehousing servers, down to the laptops of mobile workers who will need to run corporate applications when they are away from the central headquarters.

4. Applications Support

To take advantage of future database-server developments, we need integrated front-end tools that are enabled for complex data (e.g., a "ToolBlade" or "Tool Extender" that complements the back-end DataBlades and Extenders from Informix and IBM, respectively). These tools might support video in the database with functions for Play and Rewind on the client. (Also see the text box "Opening Doors to Complex Data" on page 112.)

These tools may fall into a variety of categories, from 4GLs to Web authoring, database design, and OLAP-based (on-line

DBMS Vendors Weigh In

To see the future of complex-data management, consider how the major DBMS players are supporting complex data today.

Computer Associates

Instead of extending the CA-OpenIngres RDBMS, CA is marching to a different drummer with its focus on developing CA-Jasmine, an object-oriented DBMS that will also include robust data management capabilities. CA does not believe that an object-relational architecture will be successful in the long run, and the company is betting on its ability to deliver CA-Jasmine plus Jasmine Application Development Environment (JADE) on the front end, with access to legacy data, including relational data, on the back end. CA is shipping the SDK for CA-Jasmine.

IBM

Big Blue was one of the first RDBMS vendors to ship object-relational capabilities with DB2 Common Server 2 and its optional Relational Extenders for text, image, audio, and video data. The new release, which is dubbed DB2 Universal Database, merges DB2 Common Server and DB2 Parallel Edition, combining enhanced object-relational capabilities with parallel processing on symmetric multiprocessing (SMP), massively parallel processing (MPP), and cluster platforms. IBM is working with partners to develop a broader library of Extenders.

Informix Software

Informix-Universal Server is already in controlled release, with general availability targeted for sometime this quarter. Informix-Universal Server combines the core database engine of Informix-OnLine 7.2, including support for parallel processing on SMP platforms, with a broad set of object-relational extensions and the DataBlade API acquired with Illustra Information Technologies early last year. One of Informix's major advantages is the number of third-party partners committed to developing DataBlade modules for Informix-Universal Server (see "RDBMSes Get a Make-Over" on page 109).

Microsoft

The company is betting on its OLE DB interfaces to unify application access to a multitude of data sources. OLE DB addresses universal access to data through middleware rather than universal management of data in terms of storage and manipulation in a single back-end server.

Oracle

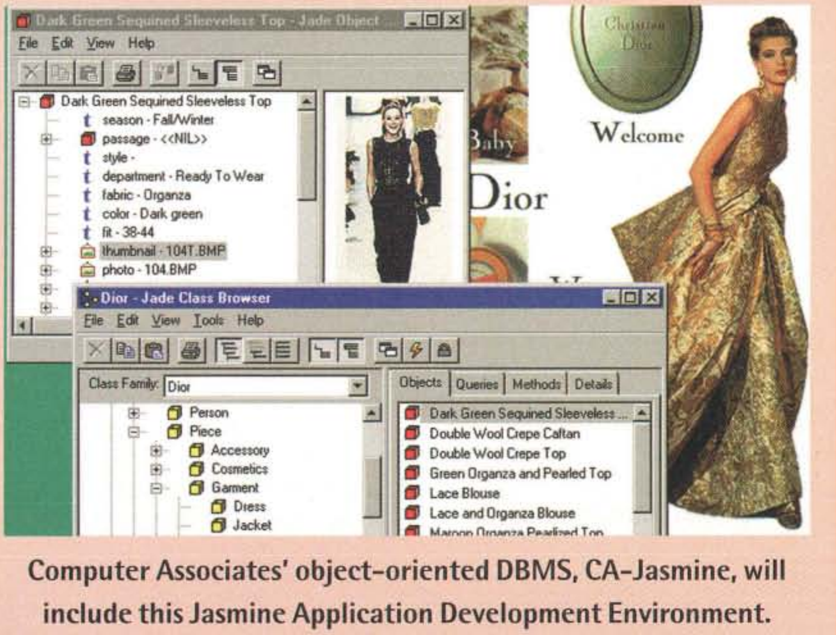
We expect Oracle to roll out extensive object-relational capabilities in Oracle 8. We understand this is currently in beta testing, although the company has not publicly announced either its specific product plan or a release date.

Sybase

Sybase plans to introduce object-relational extensions in its SQL Server database server in two steps. The next release of SQL Server (currently referred to as Adaptive Server) will support the integration of SQL Server data with specialty data stores, called *snap-in servers*. Each snap-in server manages a specific type of complex data and uses the Open Server API for SQL Server connectivity. SQL Server will include the distributed query capability of OmniConnect to support queries across data stored in these multiple servers. Already available for SQL Server 11 are spatial and time-series servers, with the development of others under way. The second step will be object extensions in SQL Server itself.

Object-Oriented DBMSes

The object-oriented DBMS vendors are still relatively small in size and installed base compared to their RDBMS competitors. Companies such as GemStone, Object Design, and Versant are focusing on Web applications as the ideal applications for their wares. Another thrust is providing a DBMS geared for the persistent storage of Java objects.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Computer Associates' object-oriented DBMS, CA-Jasmine, will include this Jasmine Application Development Environment.

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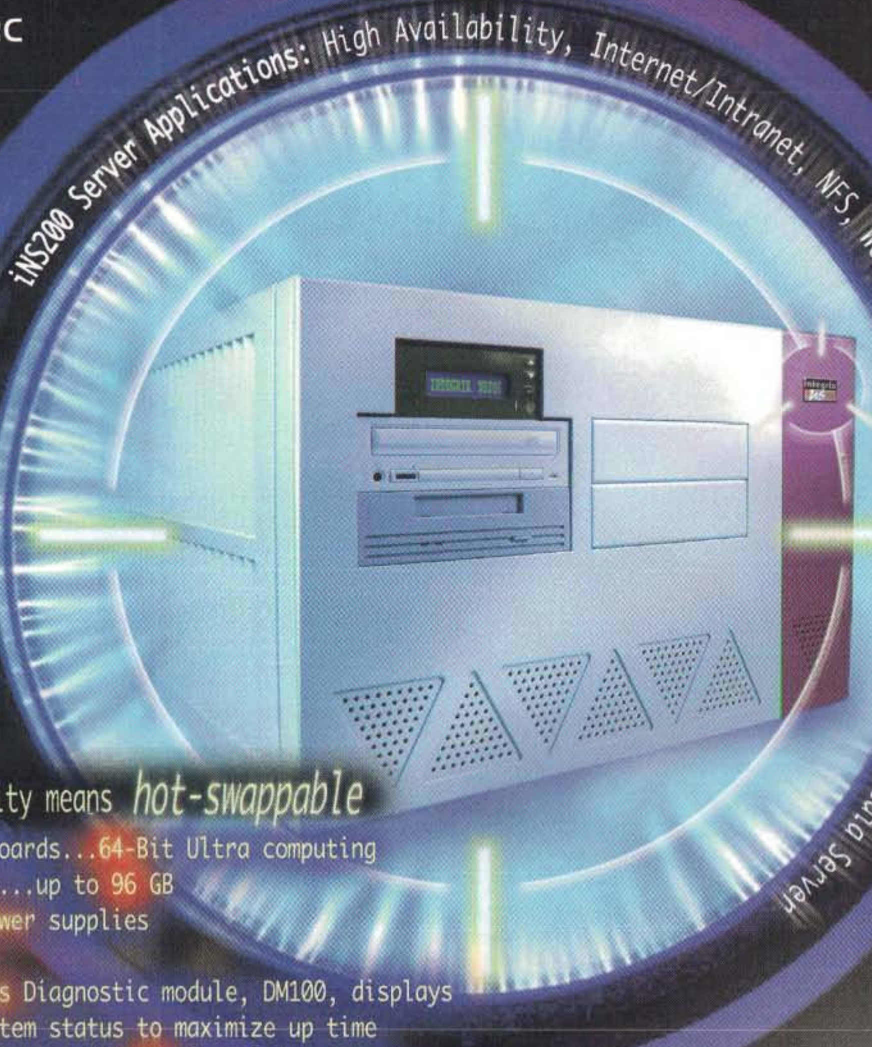

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analytical processing) data-warehousing tools. Many 4GLs use the Open Database Connectivity (ODBC) API as a database-connection strategy. However, ODBC does not support rich data types and other extensions. To do so, the API must evolve to a SQL3 level.

Today, applications can get back only traditional numbers and characters, and maybe binary large objects (BLObs), from the DBMS. In the future, applications will need the semantics to come back with the objects, so that BLObs, for example, are returned as typed objects.

Data warehouses deal mainly with numbers and character strings. If we put information about parts in the data warehouse, we also want documentation describing the parts using drawings and maps of the geographic location of warehouses.

We also must expand the notion of client-side processing in the DBMS development environment. This would include class libraries for Java and C++ or ActiveX controls. In addition, 4GLs need to be Web-enabled so developers can write a 4GL application once and deploy it in either a traditional client/server or a Web environment. Also, 4GLs need to support a two-tiered development model, where one group of developers can create applications building blocks, and another group can create actual applications by assembling these components.

Catalysts for Complex Data

What are the killer applications that may drive the widespread adoption of applications that use complex-data types?

The Web may be the biggest catalyst. Companies can gain a competitive advantage by providing access to both structured and complex data (multimedia in particular) through Internet-based information servers.

These servers will contain not only all types of data, but also the application and business logic necessary to understand and transform the data into valuable information. Critical to the success of these applications will be how quickly customers get the information they need, and here the overall performance of the Internet will influence end-user acceptance.

Besides information servers, we may see a variety of industry-specific complex-data applications. One example may evolve from the long-standing need in financial services to support time-series data and sophisticated data modeling. Various industries also need geographic applications that deal with 2-D spatial data, maps, and images.

5. Off-the-Shelf Components

Prebuilt components will be critical to the acceptance of complex-data applications. DBMS vendors are already providing basic extensions (e.g., libraries of image data types, functions, and search methods) that developers can use as building blocks for custom applications. DBMS vendors are also partnering with a wide variety of software companies to write specific extensions to the DBMS. These efforts will result in "meta" components that integrate basic components into useful packages by layering on higher-level business capabilities. Ultimately, we may be able to buy full applications—an accounting, OLAP, or multimedia asset management system, for example—built from components as an extension to the DBMS.

Related Technologies

A great deal needs to be done within DBMSes to make complex-data management more efficient. An example is sophisticated optimization algorithms to take advantage of new access methods and parallel processing. Yet, DBMS engines aren't the only component. Ancillary technologies must also evolve to help us create, store, maintain, and access data that does not fit neatly into rows and columns.

The processing performance necessary for handling complex-data types will come from multiple sources–newer and faster processor designs, faster memory, higher-density storage, large-bandwidth networks, and OS enhancements.

Chip densities will continue to double every 18 months or so for the foreseeable future, which will help with the raw processing power needed for future data-processing demands. Similarly, 64-bit systems, such as those available from Sun, will arrive from IBM, the Hewlett-Packard/Intel partnership, and others. OSes with very large memory capabilities will benefit compute-intensive applications using complex-data types.

Similarly, symmetric multiprocessing (SMP), massively parallel processing (MPP), clustering, and hybrid-processor architectures will continue to make their presence felt, especially in data warehousing. At the same time, we'll see megabits of memory per chip, with sizes quadrupling about every three years. Magnetic-storage areal density (i.e., the number of bits stored in a given area of disk surface) under the newer magnetoresistive head technology is growing at a rate of 60 percent per year. Network technologies such as ISDN, Asymmetric Digital Subscriber Line (ADSL), and cable modems are evolving to satisfy the Internet's voracious appetite for bandwidth.

Nevertheless, there are at least two obstacles to overcome. One is the need for these technologies to conform to standards for interoperability. The second is achieving an acceptable total cost of ownership for these technologies.

6. Client-Side Optimization

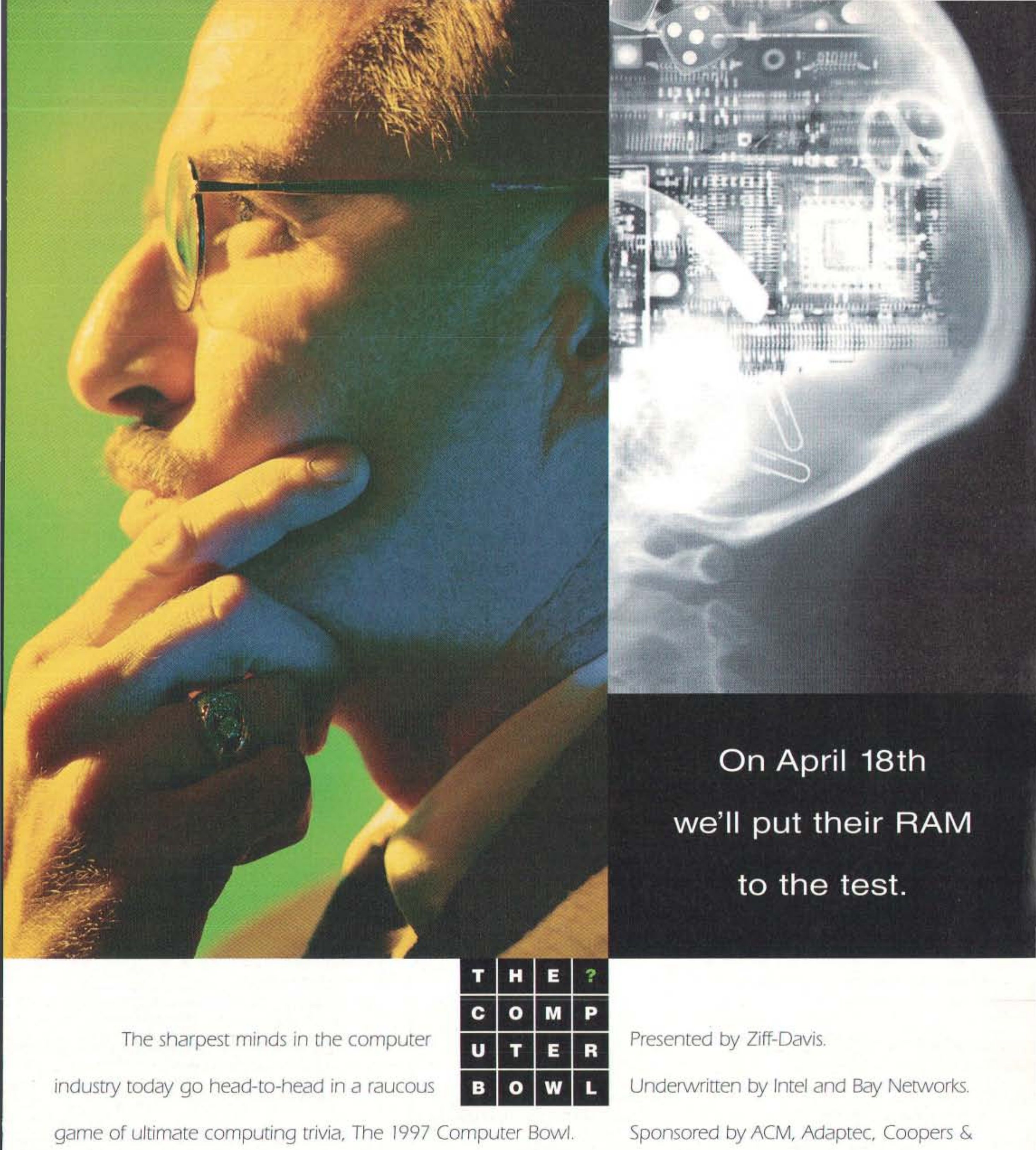
More effective support for objects on the client side will also be important. This includes client cache management and the ability to execute functions and optimization techniques outside the database (i.e., on applications servers or the client). All these features will help avoid unnecessary network traffic and improve client-side performance. Another goal is better integration with object-oriented programming languages. IBM is working in this area, and we expect that other vendors will as well. A related issue is support for and integration with distributed-object middleware, such as Common Object Request Broker Architecture (CORBA), IIOP, and Distributed Common Object Model (DCOM).

7. Server-Side Optimization

DBMSes still have work to do to understand how to apply parallel operations to user-defined objects, code, and index structures. Other requirements include better integration of complex data with utilities (e.g., load/unload) and replication.

Future Considerations

In the short term, it is unlikely that there will be widespread use of complex data in commercial applications. The total cost of ownership—in terms of software and



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hardware—will be high, and the database technologies will be relatively immature. Also, we'll lack integrated development, querying, and optimization tools.

In the longer term, however, two key factors will determine whether we see the widespread adoption of complex-data types. One will be how quickly costs fall for the necessary technologies. The second factor will be how quickly organizations identify killer applications that justify migration to the new technology.

Barring a complete breakdown of the Internet infrastructure, we believe complex data will become ubiquitous on the Web with commodity applications within three to seven years, at least in the U.S. Other countries traditionally have higher capitalization and unit costs, and may not see the same market penetration and exploitation experienced in a similar time frame. The use of complex data over corporate intranets will follow the classic bell curve, with perhaps 25 percent to 50 percent adoption of the technology on an ongoing and regular basis over the next three to seven years. **B**

Key Questions

As you make decisions about which DBMS technologies to choose for complex-data management, you should consider the following questions:

① How mature are they?

② For what applications are they best suited?

③ What is the total cost of the technologies in terms of hardware, software, and human resources?

④ What tools are available to design, develop, implement, and manage complex-data applications?

⑤ What capabilities are there to migrate from or integrate with legacy systems?

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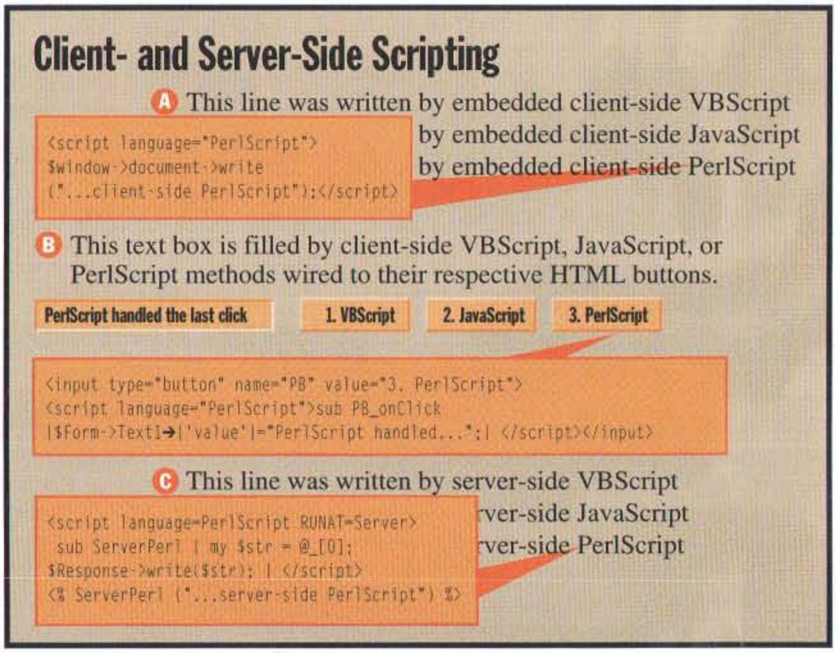
Circle 133 on Inquiry Card (RESELLERS: 134).

Jon Udell

Web Project

Perl's Future

Perl probably won't continue to dominate Web programming, but it can still make key contributions. Will it get the chance?



Client- and Server-Side Scripting

Ⓐ This line was written by embedded client-side VBScript
by embedded client-side JavaScript
by embedded client-side PerlScript

```
<script language="PerlScript">
$window->document->write
("...client-side PerlScript");</script>
```

Ⓑ This text box is filled by client-side VBScript, JavaScript, or PerlScript methods wired to their respective HTML buttons.

```
<input type="button" name="PB" value="3. PerlScript">
<script language="PerlScript">sub PB_onClick
|$Form->Text1→|'value'|="PerlScript handled...";| </script></input>
```

Ⓒ This line was written by server-side VBScript
rver-side JavaScript
rver-side PerlScript

```
<script language=PerlScript RUNAT=Server>
 sub ServerPerl | my $str = @_[0];
$Response->write($str); | </script>
<% ServerPerl ("...server-side PerlScript") %>
```

With PerlScript, Perl can now embed in ActiveX-Scripting-aware clients (A and B) and servers (C) just as VBScript and JavaScript do.

Perl has dominated Web programming so completely that some people think the terms *Perl script* and *Common Gateway Interface (CGI) program* are synonyms. They're not. Perl scripts are just one species of the CGI genus; other species include shell scripts, Python scripts, C and C++ programs, and Java programs.

Is Perl's era of Web dominance ending? Has the CGI genus itself become an evolutionary dead end? Surveying the emerging breed of Web development tools—such as Bluestone's Sapphire/Web, Borland's IntraBuilder, Microsoft's Active Server Pages, and Symantec's Visual Café Pro, I conclude that the answer to both questions is probably yes.

These tools define a new genus in the family of Web programming systems. They build applications that can simply use essential services, such as SQL database access and session persistence. By contrast, CGI applications in general, and Perl programs in particular, must construct these support services themselves.

With each passing month, ever-fancier Web applications expect ever-richer support systems. The problem is not that you can't build these things in Perl—you can, and I do—but rather that using Perl this way takes you outside its domain of competence and erodes the spectacular productivity that attracted you to the language in the first place.

Perl likely won't dominate the next era of Internet/intranet programming, but it needn't become extinct, either. It will remain vital if its developers can answer three questions: What are Perl's strengths? Which software-development problems can Perl solve best? What in Perl needs fixing?

I've been thinking hard about these questions. In January, at a Perl summit conference sponsored by O'Reilly & Associates, I was given the rare opportunity to pitch my ideas to two of the leaders of the Perl community—Larry Wall, inventor of the language, and Tom Christiansen, a renowned Perl educator.

Why me? I'm just a halfway-decent Perl programmer, but I've focused to an unusual degree on the combination of Perl, Windows NT, and Web development. That domain introduces requirements that are different from the ones that Larry faced when he created Perl as a better way to do Unix system administration.

Today, Larry works for O'Reilly, a company known as a Unix book publisher but more recently also as a Win32 software vendor (e.g., the WebSite Web server). As O'Reilly contemplates a Perl "supported distribution" (read: product), it's imperative to understand how best to adapt the language to the needs of Win32-based developers (see the text box "The State of Win32 Perl" on page 122).

In short, Perl's at a crossroads—its Web hegemony imperiled, its Unix roots increasingly irrelevant to Win32 programmers, its Win32 extensions meaningless to Unix programmers. Given all this, here are my answers to the three big questions.

1: What are Perl's strengths?

Perl has two advantages—dynamic data structures, such as lists and associative arrays, and powerful text processing based

PHOTOGRAPH: KELLIE WALSH © 1997

on a high-performance regular-expression engine. There's much more, of course, including rich networking functions, persistent data (mostly on Unix), and object orientation (in all versions of Perl 5).

The State of Win32 Perl

Dick Hardt's definitive Win32 port of Perl is now available from http://www.activeware.com/. This version tracks Perl's core, through version 5.003, adding NT-specific features, such as access to the registry and event-log APIs. It also has two Windows-specific extensions–ISAPI Perl and PerlScript–that have evolved independently of the Perl core.

ISAPI Perl is a mode that enables Perl to run in-process on Internet Information Server (IIS), WebSite, Purveyor, and other ISAPI-aware Win32 Web servers. This mode can deliver a big performance boost, although my use of it is currently restricted because ISAPI Perl can't spawn external processes (e.g., search engines).

PerlScript, just now available in beta, is a Win32 Perl that supports the Active Scripting interfaces. That means two things:

- An ActiveX Scripting host can use Perl instead of VBScript or JavaScript. The most notable client that can do this is MSIE, but other Win32 applications, including the Windows shell, will follow. The most notable server is IIS, but here, too, other Win32 apps will follow.
- Perl embedded in an ActiveX Scripting host can wield all the COM componentry available in that environment. MSIE is today the only client that supports this behavior, and IIS the only server, but any Win32 application that adopts ActiveX Scripting can use Perl this way.

However, these additional features are not what makes Perl special; they're also available in other languages, notably Java. Perl's text-processing and data-manipulation features are its real claim to fame. A classic Perl application scans a quantity of structured text, absorbs pattern-matched regions into automatically allocated data structures, rearranges those objects, and emits structured text that has been transformed in some crucial way.

In short, Perl shines when you need to write a filter. It owes its prowess in this realm to more than raw technical underpinnings. Larry is a linguist by training, and he sought to recapture for the learner of Perl the smooth progression from beginner to expert that we all experience when we learn natural languages. He hopes you'll get decent results right away, even with minimal competence, and for many users—including me—that's been true.

Larry also sought to recapture in Perl some of the syntactic flexibility of natural languages. A Chomksyan linguist says that there are many ways in which surface structures (i.e., sentences) can map to deep structures (i.e., meanings). The corresponding Perl mantra is: "There's more than one way to do it." You might parse a line of text using the split operator, while I might do it quite differently with a parameterized regular-expression search; either will get the job done.

Not all Perl programmers buy into these linguistic analogies. Some find aspects of the language baroque or just plain weird. But we all prize the rapid development that Perl's interpretive mode makes possible. We are, as Larry says, "desperate people in a hurry." We want results now, and Perl operating in its domain of competence delivers like no other tool can.

2: Which software-development problems can Perl solve best?

In a certain sense, the Internet is just a vast collection of structured ASCII texts—Web pages, e-mail messages, Usenet postings, and configuration and log files. That is why Perl has enabled me to build lots of useful Internet applications quickly and easily. These apps, including my log-analysis scripts, our Web/NNTP conferencing system, and the Virtual Press Room, are all examples of the kind of filtering at which Perl excels.

Data reduction and analysis. My Web-server log-analysis scripts are data reducers that boil down tens of megabytes of daily log data into reports that show how our audience uses our on-line content.

Data conversion. Our conferencing system is a data converter. It relies on a text-transformation script (Earl Hood's MHonArc) that converts RFC 822 messages that are stored in an INND database into a read-only Web archive, in addition to another script that converts that simple Web archive into a fancier frame-based one that supports posting.

Document collection and management. The Virtual Press Room manages a database of user-contributed documents. It validates input, activates uniform resource locators (URLs), automatically constructs tabbed indexes for navigation, and performs full-text indexing.

Where's the database that manages all this information? In some cases, you'll find my Perl applications talking through Open Database Connectivity (ODBC) to SQL data stores. When the site's cumulative visitor count passed the quarter-million mark, for example, my 64-MB NT box could no longer handle that data using a Perl associative array backed by a text file, so I moved it into a SQL table. And when I began to analyze survey data, Perl's procedural approach gave way to SQL's declarative one. But in many cases you'll find my apps managing data using nothing more than Perl and the file system.

This might seem perverse, but in fact it's highly productive. A great many useful apps don't require the capacity, query capability, or transactional controls of a SQL engine. Use Perl to manage the data in these cases, and you can dramatically speed up the evolution of your data model.

Have you noticed how all the rapid application development (RAD) tools bog down in the data-definition phase? You might not need to declare variables, but you do have to define SQL tables, map your code to them, and keep the code and tables in sync. You also have to use SQL tools to populate the tables with test data and then examine them while debugging.

Contrast this with Perl's fluid style, in which you can straightforwardly externalize data to text files. Can real working systems possibly rely on this technique? Well, the Internet does. Human-readable protocols and data stores make it possible to extend and debug the Internet, and they account for much of its resilience.

Larry says that when the University of California's Irvine campus was built, planners just sowed grass everywhere and let the paths that emerged define where to put the sidewalks. With Perl, you can apply this method to managing data: Start growing a bunch of applications, watch how people use them, and then improve the ones that matter.

3: What in Perl needs fixing?

In the good old days, circa 1994, the Unix tools approach—scripts connected in a pipeline—worked pretty well on the Web. That approach didn't scale along with the Web, though. The two complaints most

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often heard were, "Process-creation overhead is killing us; we need to incorporate Perl into the Web server," and "Perl's too slow; we need a Perl compiler."

Both of these complaints have now been answered. ISAPI, FastCGI, and Apache-module incarnations of Perl are now available; all locate the Perl engine inside a Web server. Malcolm Beattie's Perl compiler is also now available (ftp://ftp.ox.ac.uk/pub/perl/); it converts Perl source into C source that you can compile and run.

But neither of these optimizations will drastically improve Perl's prospects relative to the new generation of Web-development tools. Why not? You can't optimize a flawed algorithm. The next-century equivalent of the Unix pipeline will be a distributed-object system consisting of COM- and/or CORBA-style objects. To thrive, Perl (or any scripting language) will have to be an effective user of objects, a producer of objects, or both.

Note that by *objects* I do not mean Perl 5 objects that you can export from Perl modules, inherit from in other Perl modules, and use in Perl programs. Perl's internal object system is a wonderful thing, but it's private to Perl and does not connect it to public COM or CORBA object systems.

On Win32, Perl is already an effective controller of COM objects. It has long been able to manipulate the object systems of COM-aware applications, such as Microsoft Word, and thereby script their behavior from the outside. PerlScript adds the ability to do the same thing from the inside—that is, it can become the embedded scripting language for applications that support ActiveX Scripting.

The most interesting such application will likely be the Windows 97 shell. To unify the desktop and the Internet, Microsoft plans to turn the shell into a dynamic Hypertext Markup Language (HTML) system. In theory, that means that you could do a View Source on the shell at any time and reveal the HTML description that produced what's on-screen. That description will mix formatted text, object invocations that interpolate values into formatted text, and inclusions of active content.

Would you rather write a Visual Basic (VB) program or a PerlScript program to generate that description? I'll take PerlScript. It's vastly more competent in this realm than VB is.

Not all uses of PerlScript are so compelling. Many of the current Active Server Pages demos use JavaScript or VBScript interchangeably to control COM objects that, for example, talk to databases. It's nifty that PerlScript can now substitute for JavaScript and VBScript in this context. But if your application just calls an Active Data Object (ADO) connection in a loop and prints SQL rows to an HTML table, there's no particular reason to prefer PerlScript over the alternatives. In other words, many applications don't involve the kinds of sophisticated text processing and dynamic data manipulation that are the special province of Perl.

BOOKNOTE

Programming Perl—Second Edition
$39.95
by Larry Wall, Tom Christiansen, and Randal L. Schwartz
O'Reilly & Associates
http://www.ora.com/

The second edition of "the Camel Book" delves into all the fancy new Perl 5 stuff: objects, references, and complex data structures.

TOOLWATCH

PerlScript
free
ActiveWare
http://www.activeware.com/

Dick Hardt's definitive Win32 Perl now includes support for ActiveX Scripting. That means you can use Perl as the embedded script engine in Win32 clients (e.g., MSIE) and servers (e.g., IIS).

Thanks to ActiveX Scripting, Win32 is becoming an equal-opportunity environment for embedded script engines. When PerlScript is an appropriate solution, you'll be able to deploy it.

Object Producer

Because Perl can't produce COM or CORBA objects, it unfortunately does not enjoy equal opportunity in the realm of object services. Consider two examples from the COM world: Visual Interdev and Internet Information Server (IIS)/Transaction Server. (CORBA fans, bear with me. This point would apply equally to CORBA, but concrete examples come less easily to mind.)

Visual Interdev, Microsoft's new integrated development environment (IDE) for Web developers, advances the notion of design-time controls. These are COM objects that you use to interactively define the behavior of chunks of active content. Specifically, a design-time control packages a GUI with a code generator that writes Active Server Pages–style HTML for IIS.

What would it take to retarget Visual Interdev to, say, LiveWire? You'd need a different code generator that could write LiveWire-style HTML. Perl to the rescue? Not unless someone figures out how to package Perl's text-wrangling services as a COM object that Visual Interdev can use.

Now consider IIS/Transaction Server. Let's say you've got a Web application that could benefit from Perl's dynamic data structures—if those structures could be made persistent, and if the application could scale to accommodate lots of users. IIS 3.0 has a solution for persistence. Its built-in Application object can remember things across HTTP transactions. Of course, if you have to decompose your rich Perl data into the simple scalars and lists that an Application object can hold, you've lost the benefit of Perl.

Alternatively, you can hand the Application object a reference to another COM object. If Perl could inhabit COM objects, that might be a way to retain Perl's data-wrangling services while leveraging the persistence services of the Active Server Pages environment.

Your COM-based Perl code could also enjoy the benefits of Transaction Server. That way, you could let the environment into which you plug your Perl objects solve the hard problems of multithreading, concurrency, locking, and transaction atomicity. Re-creating these services in Perl is not the way to go! Perl, and other script languages, ought rather to configure themselves so they can plug in where needed and run efficiently in those niches.

To make this work would require what Larry likes to call "deep magic." I suspect (and he agrees) that it would also require some sort of Perl run-time system. VB 5, which can generate ActiveX controls that rely on a VB run-time system, illustrates the concept.

Will Perl go this route? I hope so. It'll be a shame if component producers can't solve Perlish problems in Perl.

Jon Udell is BYTE's executive editor for new media. You can reach him by sending e-mail to **jon_u@dev5.byte.com.**

Rick Grehan

Javatalk

SuperCede Lives Up to Its Name

Patch an executing method on the fly? Maybe in Smalltalk, but not in Java... until now.

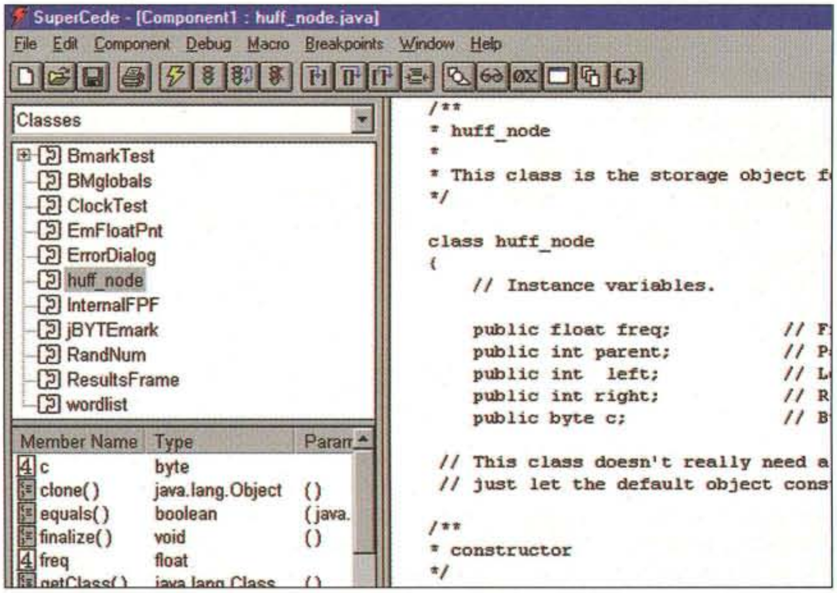
I didn't expect a Java tool to have the power of SuperCede. I also didn't expect Asymetrix, the purveyor of ToolBook, to release any Java tool at all. In both cases, I am happy to have been taken by surprise.

Asymetrix's claims for SuperCede, which runs on Windows 95 or NT, are similar to those made by other vendors of Java development tools. To wit: SuperCede is faster than anything else in the areas of development, debugging, and execution. However, what's different about SuperCede is that it lives up to these claims. Also, I can find many of SuperCede's features in no other product—at least, not yet.

On the Surface

SuperCede gathers the elements of your Java application or applet using the familiar project paradigm. However, a single SuperCede project can contain more than one component; a component is a "buildable" entity—usually an application or applet.

When you double-click on a component in the project window, SuperCede opens its component window. This looks a great deal like the two-pane window setup found in Microsoft's Developer Studio. The left half of the component window is the browser pane, which includes the browser listbox at its top. The right half of the component window holds the editor pane.



SuperCede - [Component1 : huff_node.java]
File Edit Component Debug Macro Breakpoints Window Help
Classes

- BmarkTest
- BMglobals
- ClockTest
- EmFloatPnt
- ErrorDialog
- huff_node
- InternalFPF
- jBYTEmark
- RandNum
- ResultsFrame
- wordlist

Member Name	Type	Param
c	byte	
clone()	java.lang.Object	()
equals()	boolean	(java.
finalize()	void	()
freq	float	
getClass()	java.lang.Class	()

```
/**
* huff_node
*
* This class is the storage object f
*/

class huff_node
{
    // Instance variables.

    public float freq;            // F
    public int parent;            // P
    public int  left;             // L
    public int right;             // R
    public byte c;                // B

 // This class doesn't really need a
 // just let the default object cons

/**
* constructor
*/
```

SuperCede's component window hosts a variety of editors.

These two panes work in concert. Each choice in the browser list selects a category and populates the browser pane with a roster of entities in that category, including source files, forms, compilation order, content files (e.g., bit maps or cursors), imported DLLs, external files, and classes. When you choose an entity from within the browser pane, an appropriate editor opens in the editor pane. For example, if you choose a source file from the browser pane, the editor pane loads the source and turns into a text editor. If you choose a form from the browser pane, the editor pane becomes a forms editor.

I've seen many techniques used in integrated development environments (IDEs) to help you in the discipline of forms design. Some forms editors let you enable a grid and turn on the grid's "snap-to" feature. Others let you select a group of related controls and align them all horizontally and vertically.

SuperCede's forms editor has an alignment tool that I've never seen before. Along the left and top outside of the form are rulers. If you click on either ruler, a tab appears attached to a dashed line that stretches either horizontally or vertically across the form. When you slide the tab and the attached line slides with it, the line sweeps across the form and gathers controls that it touches. You sweep controls into position.

On-the-Fly Debugging

SuperCede really shines as a debugging platform—you can hot-patch a running application. Suppose you're debugging a program and discover that a method doesn't work properly. Maybe you've built a sort method that isn't sorting correctly. While the application is still executing, SuperCede lets you drop back into the component window, pull up the source code in the editor pane, make the change, and hit the "update" key. SuperCede will recompile the changed method

PHOTOGRAPH: KELLIE WALSH © 1997

Going Native

A `native` method is Java's mechanism for calling on C/C++ routines. Declare a method as `native`, and at execution time, the Java application or applet will know that the method is separately compiled C/C++ code.

The Java native interface (JNI) defined by the Java Developer's Kit 1.1, although an improvement over the interface definition of the previous JDK, is intricate enough to require serious study before you can easily use it. The need for its complexity is understandable: The native interface the JDK defines has to be implementable on virtual machines (VMs) across all Java platforms.

On the Java side, to call a `native` method, you must first declare it `native`. Next, your program calls the `System.loadLibrary()` call to actually load the native-code library. (You will have compiled and created the library from your C/C++ compiler.)

That's the easy part. The tough part is on the C/C++ side. Given that a method of the same name cannot exist only across classes, but also *within* classes, Java requires a mechanism for uniquely identifying all methods. The C/C++-generated `native`-method name must satisfy that requirement. You do this through *mangling*, a way of encoding the prototype of the method in its name. For example, suppose you have a Java class that calls a `native` method as follows:

```
package apkg;
class acls {native int ameth(int i, double j);
{ ... }
```

However, the C/C++ definition of the above method is:

```
jint Java_apkg_acls_ameth__ID (JNIEnv *env.
jobject jobj. jint i, jdouble j);
```

If you know the formula for mangling, you can peel the name apart to determine its Java alias. The `jint` data type specifies this as a method returning a Java integer. `Java_apkg_acls_ameth` identifies this as a `native` Java method called `ameth` in package `apkg`, class `acls`. The double underscore precedes that part of the name that identifies the method's arguments. So, the `I` specifies the first argument as being a Java integer; the `D` specifies the second argument as being a Java double.

Notice that the C function's argument list includes two extra arguments: `*env` and `jobj`. The first argument is what the JNI refers to as the *interface pointer*. It's a pointer to a set of pointers to functions in the VM. It is through the interface pointer that the C/C++ code can call into the VM and access Java classes, objects, and data. The `jobj` argument is a reference to the current object (`this`).

By contrast, SuperCede's native interface is the quintessential no-brainer. On the Java side, you merely have to declare the method as `native`. On the C/C++ side, you identify the method as you would were it a member of a C++ class. So, for the example above, the C++ code would be:

```
__java_int acls::ameth(__java_int i, __java_double j)
{ ... }
```

You fill the method's body with code, plop the file into the SuperCede integrated development environment (IDE), and compile. That's all there is to it. SuperCede takes care of the linking.

and patch the running executable file. The new method replaces the old, on the fly.

Consider what this means for the testing/debugging process. Ordinarily, when you're testing an application and you discover that something doesn't work right, you have to stop the application, retreat to the compiler, make the fix, recompile and relink, restart the application, and execute to where the problem showed up. With SuperCede, not only do you recompile and relink only the altered piece, but because the application is still running, you can return to the problem area almost instantly.

The same technology that allows SuperCede to update a running application yields other capabilities. Its debugger incorporates a *scratch* window, which is something like an expression evaluation window on steroids. You can type in any valid Java expression, including loops and methods, and SuperCede compiles and executes it on the spot. You can even instantiate an object. If you have an application stopped on a breakpoint, you can use the scratch window to explore the application's internals.

PRODUCT INFORMATION

SuperCede Java Edition
$99 through software retailers;
$109 from Asymetrix
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Bellevue, WA
(800) 448-6543
(206) 462-0501
scbyte@asymetrix.com
http://www.supercede.com
Circle 1088 on Inquiry Card.

But Wait

SuperCede's documentation is so subtle on the following point that I nearly missed it completely: SuperCede also includes a C++ compiler. What's even more amazing is how seamlessly integrated the two compilers are. All the debugging tricks SuperCede can do in Java, it can do in C++ as well. Furthermore, because the generated Java and C++ code share the same object model, lashing `native` methods into your Java code is so simple it's almost funny (see the text box "Going Native" above).

Finally, SuperCede can build true executable files, completely circumventing the need for a Java virtual machine (VM). Of course, you must remember, those executable files can run only on Windows 95 or NT platforms.

The Catch

SuperCede's debugging on the fly works only as far as the independence of what's being updated will allow. In other words, you can edit the source code of a method, recompile, and update your executing application. However, if the old method caused some erroneous global side effect, SuperCede isn't going to know that, nor will it be able to fix it.

Finally, there is one catch to all this: Much of SuperCede's power lies in its specialized Java VM. That's not a problem during the debugging process, but if your application makes use of any SuperCede-unique capabilities, you must deploy it at a site supporting the SuperCede VM. As this article went to press, no popular browser incorporated the SuperCede VM. It would be nice if Netscape and Microsoft let users plug in their favorite Java VM. I think I know which one I'd pick. **B**

Rick Grehan is a senior technical editor for BYTE reviews and coauthor of The Client/Server Toolkit. *You can reach him at* **rick_g@bix.com.**

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Seven Fast Color Printers

These midrange printers, though still pricey, give you business-quality color without trading off performance.

By Dorothy Hudson and Dave Rowell

Desktop color laser printers have come a long way in three and a half years. Prices have dropped by almost half, and the image quality has gone from greasy 300-dpi text and grainy color images to pretty good on both counts. Vendors' cost-per-page claims are also approaching monochrome-laser levels for comparable toner coverage, and many new color lasers have fewer consumables to install and maintain. Still, it will be a few more years before color dominates the laser-printer market the way it has with ink-jet printers.

One reason for this is that color lasers sell for \$4000 to \$5000 more than monochrome lasers of comparable speed and networking capabilities. Habit is another reason. A color laser fits best when a business prints many documents that mix mostly text with spots of color or occasional all-color pages. In this situation, a color laser provides good printing speed, appropriate color quality, and a low cost per page. However, most people don't even think of augmenting business output with spot color, because it has never been an option.

Well, it is an option now. If you want to add color to a newsletter or a color bar chart to a widely distributed report, no other printer can do the job as well. Ink-jets don't have the speed (minutes per page, not pages per minute), duty cycle, or text quality. Dye-sublimation printers have gorgeous but expensive photo-image quality and require special stock. Thermal-wax-transfer printers have high page costs and need special paper, too.

A relatively new color-printer option that does compete with color laser printers is Tektronix's Phaser 350 solid-ink printer, which we include in this Lab Report along with six color lasers. The Phaser 350 has the advantages of laser-like color printing speed with a lower price. On the downside, it prints text output at the same speed as color, a maximum of 3 to 6 pages per minute (ppm) depending on the quality level. Also, it's a 300- by 600-dpi printer. It doesn't print text as sharply as some color lasers. The Phaser 350 makes a good adjunct to a network that is already equipped with monochrome lasers.

BYTE BEST

COLOR LASERS

IBM Network Color Printer
provides the best combination of print quality, speed, features, and usability.

Tektronix Phaser 350
IBM Network Color Printer
tied for best high-quality printer.

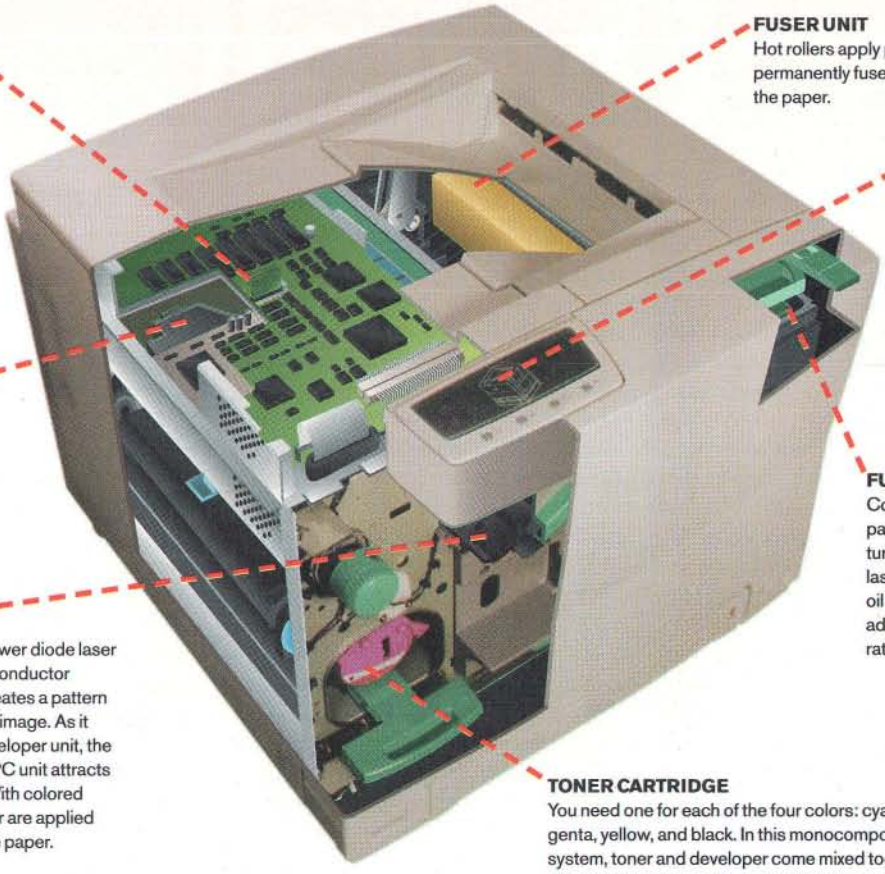
Six Lasers Plus One

The six color lasers we tested are from Apple, Hewlett-Packard, IBM, Lexmark, QMS, and Tektronix. All are capable network printers with prices as tested ranging from \$5995 to \$9778. The solid-ink Tektronix Phaser 350 costs \$5495 with the 24 MB of RAM required to print at 300- by 600-dpi resolution. We didn't test color lasers from Canon, Digital Equipment, Panasonic, and Xerox, either because a review unit wasn't available in time or because an upgraded model was close to introduction.

The laser printers have print engines with rated print speeds between 10 to 14 ppm for text and 2 to 6 ppm for color. The faster color page speeds represent lower-quality modes. We tested most of the printers with more than a standard memory configuration, so that all could print full-color pages in highest-quality mode. The QMS Magicolor CX-32 and HP Color LaserJet 5M come standard with enough memory. The test laser printers from Apple, IBM, and Lexmark use the same 600-dpi Canon P320 engine, and the Magicolor CX-32 uses a 600-dpi engine from Hitachi. HP's Color LaserJet 5M uses a 300-dpi Konica engine, while the Tektronix Phaser 550 uses a 1200-dpi KME (a division of Matsushita) engine.

While the print engine determines many basic features of a laser printer, including engine speed, base resolution, paper capacities, and consumables setup, the printer controller largely determines print quality, image-processing speed, and networking capabilities. Most of these lasers play games with laser-beam modulation, adjusting the size and placement of toner dots in the print engine's native raster array to achieve higher apparent resolution, smoother edges to curves, and/or more than the 16 colors that basic bilevel printing allows (see the Tech Focus on page 132).

HP, for example, used a 300-dpi Konica engine in its underwhelming first Color LaserJet. The Color LaserJet 5M uses the same engine, but HP has gotten remarkable quality improvements from it by using a more sophisticated controller. By modulating the timing and pulse duration of the image-writing laser beam, HP manages to approximate the text resolution of 600-dpi engines (HP claims 1200



CONTROLLER BOARD
With a fast processor, memory, support chips, and sometimes even a hard drive, the laser printer's controller board can quickly turn complex printer language commands into a bit-mapped print image. This one removes easily with two thumbscrews.

PRINTER ENGINE
Remove the controller card, case, and paper trays, and most of what you have left is the printer engine. It determines the basic capabilities of the printer.

OPC UNIT
When the printer's low-power diode laser strikes the organic photoconductor (OPC) drum surface, it creates a pattern of charge called the latent image. As it rotates past the toner/developer unit, the charged surface of the OPC unit attracts toner to form the image. With colored images, four layers of toner are applied and then transferred to the paper.

FUSER UNIT
Hot rollers apply pressure and heat to permanently fuse the colored toner to the paper.

CONTROL PANEL
Although you can manage most network lasers remotely, it's sometimes necessary and often convenient to make settings or check status at the printer itself.

FUSER OIL
Color lasers fuse toner to paper at a higher temperature than do monochrome lasers. They require fuser oil to keep toner from adhering to the roller rather than the paper.

TONER CARTRIDGE
You need one for each of the four colors: cyan, magenta, yellow, and black. In this monocomponent-toner system, toner and developer come mixed together in the same cartridge, which reduces components. The charged powder is attracted to oppositely charged areas on the OPC drum.

Illustration based on Apple's Color LaserWriter 12/660PS

dpi) when printing at 300 lines per inch.

In color-image quality, the number of colors matters as much as resolution. Laser vendors take two approaches to increase the apparent number of colors from 16, both at the expense of resolution. One is dithering, which isn't totally satisfying at 300 dpi or even 600 dpi because patterns of dots show in light areas. The other approach is to vary toner dot size by adjusting laser pulse width, a technically tricky feat that can lead to inconsistent color over time. A smaller dot appears as a lighter color. This is called contone or multilevel printing (as opposed to bilevel). Contone isn't the same as continuous tone.

You can get a greater range of colors by dropping resolution so that you can have not only smaller dots but larger ones, too. Considering its 300-dpi engine, the Color LaserJet 5M achieves remarkable color results by printing at 150 lines per inch, but with a wide variation in toner dot size that lets it approximate continuous-tone color. With its 1200-dpi resolution, the Tektronix Phaser 550 can use dithering for photo images that fool the naked eye. The other lasers in this report have 600-dpi engines, and all can do contone color, although the QMS laser combines dithering with its contone.

Muss and Fuss

With four toner colors, developer powders, fuser oil, dust collection bins, various drums, and fuser units, the number of components you must install and then replace over time can be more than 10. This makes network printer management interesting. The Tektronix Phaser 550 and the HP Color LaserJet 5M both have around a dozen parts you must install or keep track of, which didn't help their usability ratings. Canon-based lasers use a monocomponent toner that includes the developer powder, thereby cutting consumable components in half and simplifying maintenance.

Because color laser printers consume only as much pigment as they need for an image, and because they print on plain paper, they have a relatively low per-page printing cost for a color printer. This is also true for solid-ink printers. Cost per page is higher, however, than penny-per-page monochrome lasers. Because vendor differences in calculating cost-per-page estimates make comparisons a tricky business, we did not include this important factor in our ratings analysis. It's interesting that HP, which claims per-page costs that are lower than some monochrome lasers, obtains some of its economy by virtue of its nonintegrated consumables design.

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ILLUSTRATION: SANDERS/TIKKANEN DESIGN & ILLUSTRATION © 1997

Best Overall

COLOR LASER PRINTERS

Performance is important for these fastest of color printers, but not as important as print quality, a past concern with color lasers. That's why we gave print quality a 40 percent weighting in our overall rating score, followed by print speed at 26 percent. The print quality scores ranged only from good to very good, a small range that masked some strong quality differences within specific tests, particularly those involving color. Getting one of these printers to produce sharp text, good line detail, photographic halftones, vibrant color bars, *and* life-like color images is beyond current capabilities. Every one of these printers had strong and weak scores in the print quality tests.

Tektronix's 1200-dpi Phaser 550 laser, for example, has some of the best scores in the monochrome tests and did well with the CorelDraw color graphic. However, it faired poorly when performing other color tests. The solid-ink Phaser 350 has the highest overall print quality score, but it did poorly on the line tests. The Phaser 350's other monochrome scores are only average, but its color scores are top-notch, thanks to the solid, vibrant colors it prints.

Best Overall

IBM's Network Color Printer has strong scores where it matters most: print quality and performance. As our Best Overall printer, its weak points are price (the highest at $9778) and feature set. The IBM laser's high print quality score came from top ratings on the line, text, and subjectively judged color-image pages. Like the Lexmark Optra C Pro, the IBM laser uses contone color, and color images are made up of finely variegated vertical lines (200 lines per inch) visible only with a loupe. Only the Optra C Pro was faster in the performance tests.

The Network Color Printer uses the same easy-to-set-up Canon engine found in the Apple and Lexmark printers, and that strengthened its usability score. The voluminous but poorly organized IBM manuals and crude setup software for NetWare detracted from its usability, however.

IBM's secret weapon may be the Electronics for Imaging (EFI) XJE controller card that provides its text resolution and color capabilities. The easy-to-access card slides out of the printer after you loosen two thumbscrews, revealing a hard drive, a 100-MHz Mips R4600/4700 processor (under a heat sink), and three EFI Fiery ASICs. The latter off-load management functions (e.g., drive, memory, and network) from the processor so it can concentrate on raster image processing. The card is essentially a downsized version of the controllers used in EFI's XJ color servers (used with color copiers). One performance function the controller provides (that we did not test) is RIP while print (i.e., while printing the current page, the board can start image processing on the next page).

The other two Canon-based color lasers came in second and third in the overall ratings: first the Lexmark and then the Apple. Lexmark's Optra C Pro had the fastest printing speeds by far of any of the tested printers, which certainly cannot be explained by its 25-MHz AMD 29030 processor. The Optra C Pro does, however, provide the 29030 with an L2 cache, unusual for a printer. Compared to the IBM and Apple printers, the Optra C Pro's print quality is a weakness, particularly in its color scores.

Like other Optra lasers, the Optra C Pro has a four-line LCD control panel with a similar button-based interface. A 100-MB hard drive is optional. The Optra C Pro is unusual in that you can vary the gloss level on the printed page (probably by adjusting melt with fuser heat). You can also select between contone (128 color levels) or two types of dithering for color images. Contone is the slowest.

Apple's Color LaserWriter 12/660PS has its relative strength in print quality over performance. It's also the least expensive of the Canon lasers. The Color LaserWriter has a strong text score and did well on the subjective scoring of color images. It did poorly only with the monochrome photo image. It uses a 30-MHz AMD 29030 processor.

Compared to its predecessor, the 12/600PS, Apple's new model has more RAM and improved firmware, both of which improve its performance. For the Mac, it comes with native PowerPC drivers. Like other Apple printers, the front panel is minimal. Apple includes on-site installation in the price.

Tying the Apple in overall scoring is Tektronix's Phaser 350 solid-ink printer. With its fat crayon-like ink cartridges, shape-keyed for foolproof installation, it's the simplest printer to set up and the most carefree for maintenance. It has the highest usability score. More important, the Phaser 350 has the highest print quality score, just edging out IBM's laser. Performance (with text printing) is its weak point. Text pages print at the same speed as color (3 to 6 pages per minute), depending on the quality level.

Best High Quality

With its high print quality score, the Tektronix Phaser 350 ties the IBM color laser in the Best High Quality category. Where the IBM laser is strong in monochrome and some color tests, the Phaser 350 is strongest with color printing, thanks to the vivid color of its solid ink, and only average with text due to its 300- by 600-dpi resolution (with 24 MB of RAM). We're also comparing the highest- (IBM) and lowest-priced (Phaser 350) printers in this review.

The Phaser 350's color pages are brilliant, but not overly so. It's a great printer for charts and graphics. We found that we could scratch off the waxy ink with a fingernail pressed hard, but we don't believe this is a problem. Like the Phaser 550, the 350 comes with Tektronix's PhaserLink Web-browser interface (see the article "Browse This Color Laser," May 1996 BYTE), which means you can configure it and check print status over a network with any Web browser.

Compared to the Phaser 550, or any color laser, the Phaser 350' s advantages

LAB RESULTS

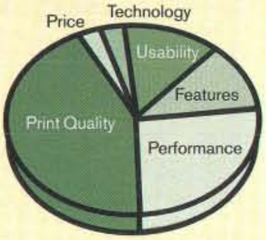
COLOR LASER PRINTERS

BEST OVERALL

IBM Network Color Printer

IBM's Network Color Printer earned a top print quality score and the second-best performance score. The printer gets its text resolution and color capabilities from its Electronics for Imaging (EFI) XJE controller card with a 100-MHz Mips R4600/4700 processor and EFI Fiery ASICs. The monocomponent design of the printer's Canon engine means reduced consumables for easier installation and upkeep.

WEIGHTING



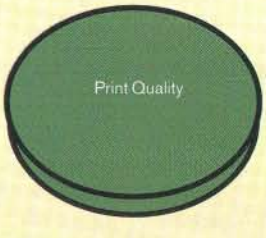
	PRICE	TECHNOLOGY	IMPLEMENTATION	PRINT QUALITY	PERFORMANCE	FEATURES	USABILITY	OVERALL RATING
IBM Network Color Printer	**$9778**	★★★★	★★★	★★★★	★★★★	★★★	★★★★	★★★★
Lexmark Optra C Pro	$7699	★★★★	★★★★	★★★	★★★★★	★★★★	★★★★	★★★★
Apple Color LaserWriter 12/660PS	$6595	★★★★	★★★★	★★★★	★★★	★★★	★★★★	★★★★
Tektronix Phaser 350	$5495	★★★★	★★★★	★★★★	★★	★★★	★★★★★	★★★★
HP Color LaserJet 5M	$5995	★★★★	★★★★	★★★	★★★	★★★★	★★★★	★★★★
Tektronix Phaser 550	$8975	★★★★	★★★★	★★★	★★★	★★★★	★★★★	★★★★
QMS Magicolor CX-32	$7999	★★★★	★★★	★★★	★★	★★★	★★★	★★★

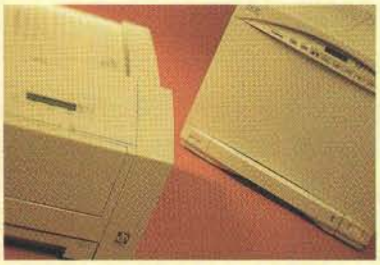
BEST HIGH QUALITY

Tektronix Phaser 350
IBM Network Color Printer

Tektronix's relatively low-cost Phaser 350 solid-ink printer tied the IBM color laser in the print quality rating. It's strongest at color printing, especially charts and graphics. The Phaser 350 is the simplest printer to set up and the most carefree for maintenance with its fat crayon-like ink cartridges, shape-keyed for foolproof installation. Also, the black ink is free of charge.

WEIGHTING





	PRICE	TECHNOLOGY	IMPLEMENTATION	PRINT QUALITY	PERFORMANCE	FEATURES	USABILITY	OVERALL RATING
Tektronix Phaser 350	**$5495**	★★★★	★★★★	★★★★	★★	★★★	★★★★★	★★★★
IBM Network Color Printer	**$9778**	★★★★	★★★	★★★★	★★★★	★★★	★★★★	★★★★
Apple Color LaserWriter 12/660PS	$6595	★★★★	★★★★	★★★★	★★★	★★★	★★★★	★★★★
Tektronix Phaser 550	$8975	★★★★	★★★★	★★★	★★★	★★★★	★★★★	★★★★
HP Color LaserJet 5M	$5995	★★★★	★★★★	★★★	★★★	★★★★	★★★★	★★★★
QMS Magicolor CX-32	$7999	★★★★	★★★	★★★	★★	★★★	★★★	★★★
Lexmark Optra C Pro	$7699	★★★★	★★★★	★★★	★★★★★	★★★★	★★★★	★★★★

★★★★★ Outstanding ★★★★ Very Good ★★★ Good ★★ Fair ★ Poor

are price, slightly faster color printing, and more vibrant color. It is slower with monochrome text printing and has less detail (300 dpi), and is therefore a good adjunct for adding color when you already have a monochrome network laser.

Coming in third in the High Quality category is the Apple LaserWriter 12/660PS already discussed, followed closely by the Tektronix Phaser 550, HP's Color LaserJet 5M, the QMS Magicolor CX-32, and Lexmark's Optra C Pro. As mentioned earlier, the Phaser 550 laser's 1200-dpi engine served it well in the monochrome tests, particularly with the photographic halftone image. It also did well with the CorelDraw color graphic, but not so well with other color tests.

The Phaser 550 scored strongly in features, and it even did well in usability, despite a difficult and involved installation procedure. Software setup, on the other hand, is fairly simple from a Windows-based installation program. In spite of the 14-ppm rated speed of its KME (a division of Matsushita) engine, the Phaser 550 didn't prove to be an exceptionally fast printer.

The HP Color LaserJet 5M scored well in features but about average in other categories. It did well in many of the color tests, but its 300-dpi native resolution hurt it with text and especially the monochrome photograph tests. With color images, you can make out a pinstriping effect, because HP uses a discernible 150 lines per inch with its contone mode. HP has also achieved a matte finish that it claims is desirable for business documents.

PHOTOGRAPHS: BRIAN WILDER © 1997

Details

Not a Laser

As a solid-ink printer, the Tektronix Phaser 350 is easier by far than a color laser to set up and manage. You insert several shape-keyed solid-ink pellets for each of the four colors and close it up. When you first turn the unit on, it takes a while for the printer to warm up—it must melt the ink.

Easy as It Gets

Printers based on Canon's color laser engine (such as this Lexmark Optra C Pro) have the easiest setup and maintenance. There are only six elements to install: four monocomponent-toner cartridges (in the rotating carousel), the organic photoconductor (OPC) unit on which the laser builds the latent image for each toner color, and the fuser oil. You access all components from one side, which makes this large laser more space-efficient.

Not So Easy

With HP's Color LaserJet 5M, consumable components number a dozen, and setup involves plenty of pull tabs and tape strips (see the inset). You refill toner with disposable bottles. A sealing mechanism reduces spillage.

TECH FOCUS LASER IMAGING

Manufacturing Color

For color printing, the ability to produce a large number of apparent colors is just as important as high resolution for producing realistic color images and smoothly shaded graphics. The difficulty in producing high-quality color with a laser printer is that the imaging process is basically binary. Where the laser strikes the organic photoconductor (OPC) drum or belt (or where it doesn't, depending on the design), toner is attracted to form the image.

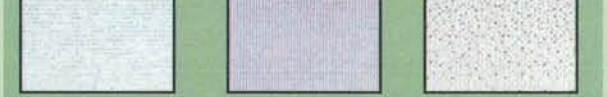
Unmodified, this binary process forms the basis for bilevel color printing. The image is built from four applications of toner (i.e., cyan, magenta, yellow, and black), where each raster dot in the image has a spot of one or more of the toners or it doesn't. A given dot in the final image can then have one of 16 colors, depending on which combinations of color toner it contains. To get more than 16 colors, a printer must resort to dithering, using clusters of differently colored raster dots to represent larger dots of more varied color. You gain a greater number of apparent colors in exchange for lower resolution and loss of detail.

A more sophisticated approach to getting more colors is to treat the laser-imaging process as partly analog. If you vary the laser pulse duration just right, you can get toner dots of different size and increase the number of colors severalfold. It's called multilevel or contone (not true continuous tone) color printing. As with dithering, you can increase color range by dropping resolution (this time as lines per inch) so that you can increase the range of dot sizes. Compared to dithering, you sacrifice less resolution to get a given number of colors.

Multilevel color printing is tricky, however. There is only a small window of pulse durations in which to adjust dot size, and small changes in pulse width bring big changes in dot size. Humidity, temperature, the age of consumable components, and the conductivity of the paper also affect the consistency of results. For these reasons, Tektronix chose bilevel dithering at a higher resolution (1200 dpi) for its Phaser 550. The company believes it gets color quality comparable to contone at 600 dpi, but with more consistency.

Printers using the Canon color-laser engine did better in our color tests than the Phaser 550 using contone printing at 600 dpi. To ensure consistency, the Canon engine calibrates itself every 100 pages or anytime you replace a toner cartridge. An optical sensor spot-checks toner density on the drum and adjusts laser pulse width accordingly. Consumables have a recommended life and yield, which also helps maintain color consistency.

Different Approaches to Color



HP's Color LaserJet 5M (left to right) uses contone at 150 lines per inch; IBM's Network Color Printer uses contone at 200 lines per inch; Tektronix's Phaser 550 dithers at 1200 dpi.

Test Specs

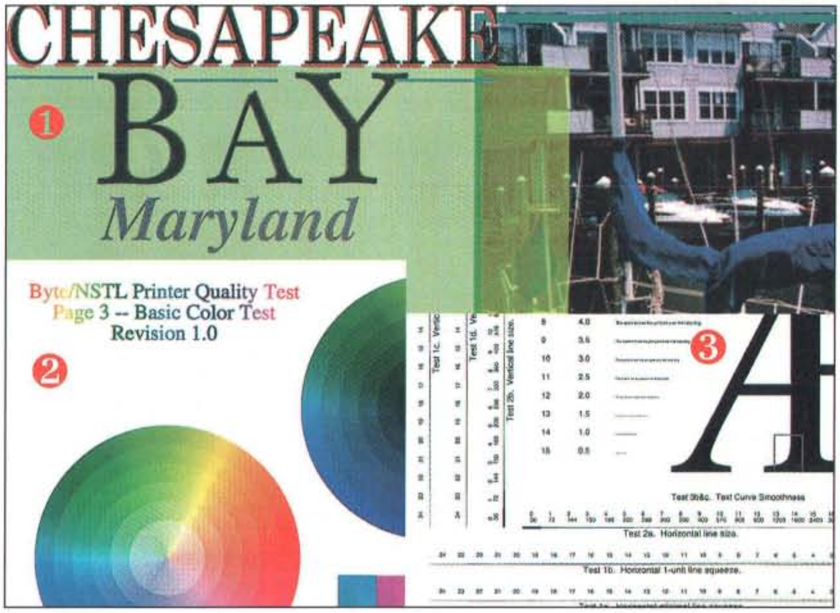
We rated color laser printers based on print quality, performance, features, usability, price, and technological innovation (on a scale of one to five stars, except for price). The Overall score comes from combined weighted ratings for all these categories (see the pie chart on page 131). We also derive an Implementation score from features, usability, and price ratings using a 40:40:20 weighting scheme. Because print quality is such a strong concern with color printers, we gave it the highest weighting (40 percent) in our Overall rating. With monochrome lasers, we lean toward performance (i.e., printing speed).

Text and Image Quality

We judged printing quality, both monochrome and color, with NSTL's standard output pages, which include text, graphics, and photographic images (see the figure). We set each printer in the mode that produced the best-quality output. In the monochrome tests, we pushed each printer's resolving power with fine horizontal and vertical lines, printed both black-on-white and the reverse. In the line squeeze test, for example, we tested resolution by gauging how closely together two lines can print without merging. Among the text-based tests, we determined the limits of legibility with decreasing font size. Higher print resolution confers an advantage with text printing, especially with finer font sizes.

Among the graphics tests, we measured a printer's ability to produce a complete range of gray scales. We judged monochrome-imaging quality with a photographic image, looking for even shading in flat areas and the ability to keep detail in both highlights and shadows. High resolution helps with detailed photographic images, too. We also measured how close a laser printed to the edges of the paper and how well it centered the print area on the page.

The color-quality pages contained a mixture of text, color photographic images, and color graphics. We printed some of these pages from Adobe Photoshop 3.0 and CorelDraw 6.0, while others were raw PostScript files. We judged pages subjectively using a jury of experienced NSTL staff members, but we also used such objective criteria as color range and fine line detail.


CHESAPEAKE
BAY
Maryland

Byte/NSTL Printer Quality Test
Page 3 -- Basic Color Test
Revision 1.0

Test 3b&c. Text Curve Smoothness
Test 2a. Horizontal line size.
Test 1b. Horizontal 1-unit line squeeze.

Among other pages, the NSTL Printer Quality Test has a color page with mixed content (1), color graphics (2), and text and fine lines (3).

Performance and the Rest

The NSTL performance tests measure how fast a printer can produce a number of basic document types: raw text, bit-mapped graphics, monochrome graphics, color graphics, and fonts. Speed testing also included both PostScript and Printer Control Language (PCL) pages. We tested speed at a printer's standard resolution (600 dpi, except for the 300-dpi HP Color LaserJet 5M) and did not use high-quality modes for performance testing. Timing started when a job was initiated and ended when the last page dropped into the printer's output tray.

Raw text tests a printer's raw engine speed as this test doesn't involve significant processing time. The various graphics tests include bit-mapped images with custom fonts and screen shots, and complex lines with fills, curves, and gray scales. The font test requires the printer to create Times and Helvetica fonts in regular and boldface in 30-point sizes, stressing the printer's processor.

We tested printing speed over a NetWare LAN (10Base-T) consisting of a single server and client. Printing originated from a Windows 95 system (the client) using printer drivers supplied or recommended by each vendor. We disabled all print servers, spoolers, and buffers during testing.

Important factors affecting our usability score are the installation process, which ranged from involved to downright difficult with these color lasers; ease of driver installation and network setup; and the quality of the manuals. We develop the features score based on our assessment of the utility of such features as networking capabilities, PCLs, driver support for different OSes, paper capacities, and warranty.

Evaluations in this report represent the judgment of BYTE editors, based on tests conducted by NSTL, Inc., as documented in a recent issue of their monthly PC Digest. *To purchase a copy of the full report, contact NSTL at 625 Ridge Pike, Conshohocken, PA 19428; (610) 941-9600; editors@nstl.com. For a subscription, call (800) 328-2776. BYTE magazine and NSTL are both operating units of The McGraw-Hill Companies, Inc.*

COLOR LASER PRINTERS FEATURES

	Apple Computer, Inc. Color LaserWriter 12/660PS	**Hewlett-Packard Co. Color LaserJet 5M**	**IBM Printing Systems Co. Network Color Printer** BYTE BEST
Price as configured (US$)	$6595	$5995	$9778
Overall rating	★★★★	★★★★	★★★★
SPECIFICATIONS			
Standard memory/as tested/max. (MB)	16/28/40	36/36/76	16/32/48
Max. engine resolution (horizontal × vertical, dpi)/memory required (MB)	600 × 600/12	300 × 300/36	600 × 600/16
Max. enhanced engine resolution (horizontal × vertical, dpi)/memory required (MB)	600 × 600/12	1200 × 1200/36	600 × 600/16
Max. color page size (letter or legal)	Legal	Legal	Legal
Standard drivers provided	Novell NetWare; Windows 3.x, 95, and NT; Mac	OS/2, Windows NT, Lotus 1-2-3, JetDirect, Novell NetWare, WordPerfect 5.x and 6.x, PostScript Level II	Windows 3.1, 95, NT, Workgroups; OS/2; AIX; Mac; Sun Solaris
Engine manufacturer, model, and technology	Canon HX LBP laser	Konica 7010 laser	Canon P320 laser
Controller manufacturer	Apple	Hewlett-Packard	EFI
Processor clock speed (MHz)	AMD 29030/30	AMD 29040 RISC/40	Mips R4600 RISC/100
NOS support	Mac; Windows 3.x, 95, and NT; Novell NetWare	Windows 3.x, 95, and NT; Unix; OS/2; LAN Server; Novell NetWare; Mac	Windows 3.x, 95, and NT; IBM AIX; Mac System 7; OS/2; Sun Solaris
Client support	Mac; Unix Windows 3.x, 95, and NT	DOS; Windows 3.x, 95, and NT; OS/2; Mac; Unix	Windows 3.1, 95, and NT; OS/2; Mac; Unix
PAPER HANDLING			
Supported paper sizes**	LTR, LGL, A4, B5, TRANS	LTR, LGL, A4, A3, TAB, EXEC, TRANS	LTR, LGL, A4, B5, TAB, EXEC, ENV, TRANS, ABL
Duplex option			
Standard input tray capacity/output tray capacity (number of sheets)	250/100	250/100	250/120
Number of standard input trays/ max. input trays	2/3	1/2	2/3
Max. input tray capacity (number of sheets in all trays)	500	500	600
Envelope feeder			
Legal-size input tray		✓	✓
INTERFACES			
Centronics parallel	✓	✓	✓
RS-232			
Apple LocalTalk	✓	✓	
Ethernet	✓	✓	✓
Token Ring			Optional
SCSI-1			
Auto-switching among all interfaces	✓	✓	✓
EMULATIONS			
HPGL		✓	
PostScript Level I	✓	✓	
PostScript Level II	✓	✓	✓
Intellifont		✓	✓
True Image		✓	✓
HP PCL5		✓	
Auto-switching among emulations	N/A	✓	N/A
FONTS			
Number of resident fonts	35	46	39
Number of resident bit-mapped fonts/resident scalable fonts	0/35	1/45	0/39
MANUFACTURER'S RATINGS			
Monthly duty cycle (pages printed per month)	20,000	30,000	15,000
Monochrome pages per minute in standard mode	12	10	12
Color pages per minute in standard mode	3	2 to 3	3
Voltage (120 or 220)	110	115 to 127	Both
FCC classification	B	B	B
DIMENSIONS			
Width × length × height (inches) w/ standard tray configuration	21 × 24 × 18	24.4 × 19.3 × 14.8	21.6 × 23.2 × 18.4
Weight (lbs.) w/ standard tray configuration	110	102.5	110
CUSTOMER SUPPORT			
Warranty length (years)/coverage	1/P, L	1/P, L, F, R	1/P, L
Toll-free phone	(800) 538-9696 ext. 525	(800) 527-3753	(800) 358-6661
Phone	Call local Apple dealer	Call local H-P dealer	(404) 238-1234
On-line address	http://www.apple.com	http://www.hp.com	http://www.can.ibm.com
Inquiry number	**1078**	**1079**	**1080**

BYTE BEST = BYTE Best

✓ = yes;
N/A = not applicable.

Warranty: P = parts; L = labor;
F = freight to repair center; R = return to customer.

★★★★★ Outstanding ★★★★ Very Good ★★★ Good
★★ Fair ★ Poor

Lexmark International, Inc. Optra C Pro	**QMS, Inc. Magicolor CX-32**	**Tektronix, Inc. Phaser 350** BYTE BEST	**Tektronix, Inc. Phaser 550**
$7699	$7999	$5495	$8975
★★★★	★★★	★★★★	★★★★
8/32/64	32/32/64	8/24/24	8/24/72
600×600/32	600×600/32	300×600/24	1200×1200/24
600×600/32	1200×600/40	300×600/24	1200×1200/24
Legal	Letter	Letter	Legal
Windows 3.1, 95, NT Server; System 7; OS/2 Warp; DOS	Windows 3.x, 95, NT; Mac	Windows 3.x, 95, NT; Mac; OS/2	Windows 3.x, 95, and NT; Mac: OS/2
Canon P320 laser	Hitachi Sleur laser	Tektronix Z350 solid ink	KME 2550 laser
Lexmark	QMS	Tektronix	Tektronix
AMD 29030/25	IDT 3081 RISC/40	AMD 29030/32	AMD 29030/32
NetWare 3.x and 4.x, IBM LAN Server, Banyan Vines, OS/2 Warp Server, Windows NT Server, Mac, Unix, AS/400	NetWare 3.x and 4.x, Mac	NetWare 3.x and 4.x, Mac	Novell NetWare; Unix; Windows NT; Mac
DOS; Windows 3.x, 95, and NT; OS/2; Mac; Unix	Windows 3.x, 95, and NT; Mac; Unix	DOS; Windows 3.x, 95, and NT; OS/2; Mac; Unix	DOS; Windows 3.x, 95, and NT; OS/2; Mac; Unix
LTR, LGL, A4, B5, TRANS	LTR, LGL, A4, TRANS, ABL	LTR, A4, TRANS	LTR, LGL, A4, TRANS ABL
✓			✓
250/100	250/150	200/250	250/250
2/3	1/2	1/2	1/3
600	500	700	750
	Optional		
✓	✓		Optional
✓	✓	✓	✓
✓	✓	Optional	Optional
✓	✓	Optional	Optional
✓	✓	Optional	Optional
Optional	✓	Optional	✓
	✓	✓	✓
✓	✓	✓	✓
✓	✓	✓	✓
	✓	✓	✓
✓	✓	✓	✓
✓	✓	✓	✓
		✓	
✓	✓	✓	✓
✓	✓	✓	✓
86	58	17	39
2/84	7/51	0/17	14/25
15,000	20,000 monochrome; 5000 color	N/A	N/A
12	12	4	14
3	3 to 6	4	5
Both	180 to 260	Both	Both
B	A	B	B
21.3×22.8×18	20.5×22.2×16.4	15.8×19.8×13	27.4×19.5×18
110	106	68	117
1/P, L	1/P, L, F, R	1/P, L, R	1/P, L, R
(800) 358-5835	(800) 523-2696	(800) 835-6100	(800) 835-6100
(606) 232-2000	(334) 633-4300	(503) 682-7377	(503) 682-7377
http://www.lexmark.com	http://www.qms.com	http://www.tek.com	http://www.tek.com
1081	**1082**	**1083**	**1084**

**LTR=Letter (8.5×11 inches)
EXEC=Executive (7.25×10.5 inches)
LGL - Legal (8.5×14 inches)
ENV=Envelope
A4 (8.26×11.69 inches)
TRANS=Transparencies
B5 (6.9×9.8 inches)
ABL=Adhesive-backed labels
TAB=Tabloid (11×17 inches)

Hanging Out an Internet Shingle

New packages that run under Windows NT provide one-stop shopping for setting up a Web storefront.

By David Seachrist

Building a store on the World Wide Web can be just as complicated as building a store in the real world. You have just as many choices to make. Mirroring the real-world choices, from pushcart to megastore, Web merchants can opt for modest yet all-inclusive storefront packages or go all the way with high-end commerce products.

For this report, NSTL tested three all-in-one, entry-level Internet-storefront packages. All three run under Windows NT, and each includes a Web server, database, and tools for creating the actual Web content, making them stand-alone products. We also looked at (but did not completely test) three high-end commerce-server suites from Microsoft, Netscape, and Open Market (see the text box "High-End Commerce Servers" on page 140).

If you don't mind paying the higher price tag of $4995, NetConsult Communications' Intershop Online was the most versatile and the easiest to use of the three packages that we tested. However, Merchant Builder from the Internet Factory and iCat's Electronic Commerce Suite have plenty to offer beyond their lower cost.

All three products we tested mix a Web server to host the Web storefront with a database (or database access) to keep track of products, fold in support for Internet commerce and security protocols, season with site management and creation tools, and garnish well with Web-page templates. Choosing the best storefront package depends greatly on where you place the intersection of product features with your needs.

Paying the Piper

Taking care of business on the Web is complicated by the openness of the Internet. You don't want customers sending credit-card numbers to you in the clear. The Secure Sockets Layer (SSL) protocol originated by Netscape has become the de facto standard for encrypting TCP streams (e.g., HTTP sessions) using the de facto cryptographic standard, the Rivest-Shamir-Adleman (RSA) patented public-key algorithms. Another standard that servers widely support is S-HTTP, which you can use to encrypt individual Web transfers—although there aren't many browsers that support S-HTTP.

BYTE BEST

WEB STOREFRONTS

Intershop Online

Intershop Online comes the closest to a turnkey storefront by offering a strong back-office database, an organized and complete sample store, helpful documentation, useful business management tools, strong platform support, and secure and convenient store administration. It is well worth its $4995 price tag.

Encryption isn't enough protection, though, so Visa and MasterCard, along with software and hardware vendors, have cooperated on the Secure Electronic Transaction (SET) specification for online commerce. Using public-key-encrypted digital signatures, SET aims to protect transactions and reduce fraud.

All-purpose storefront packages should support all these standards, even though final approval of the SET standard isn't expected before summer. In the meantime, SSL and S-HTTP are handy for securely transmitting information products as well as credit-card numbers, even though most credit-card issuers are urging their cardholders to do business only when using SET.

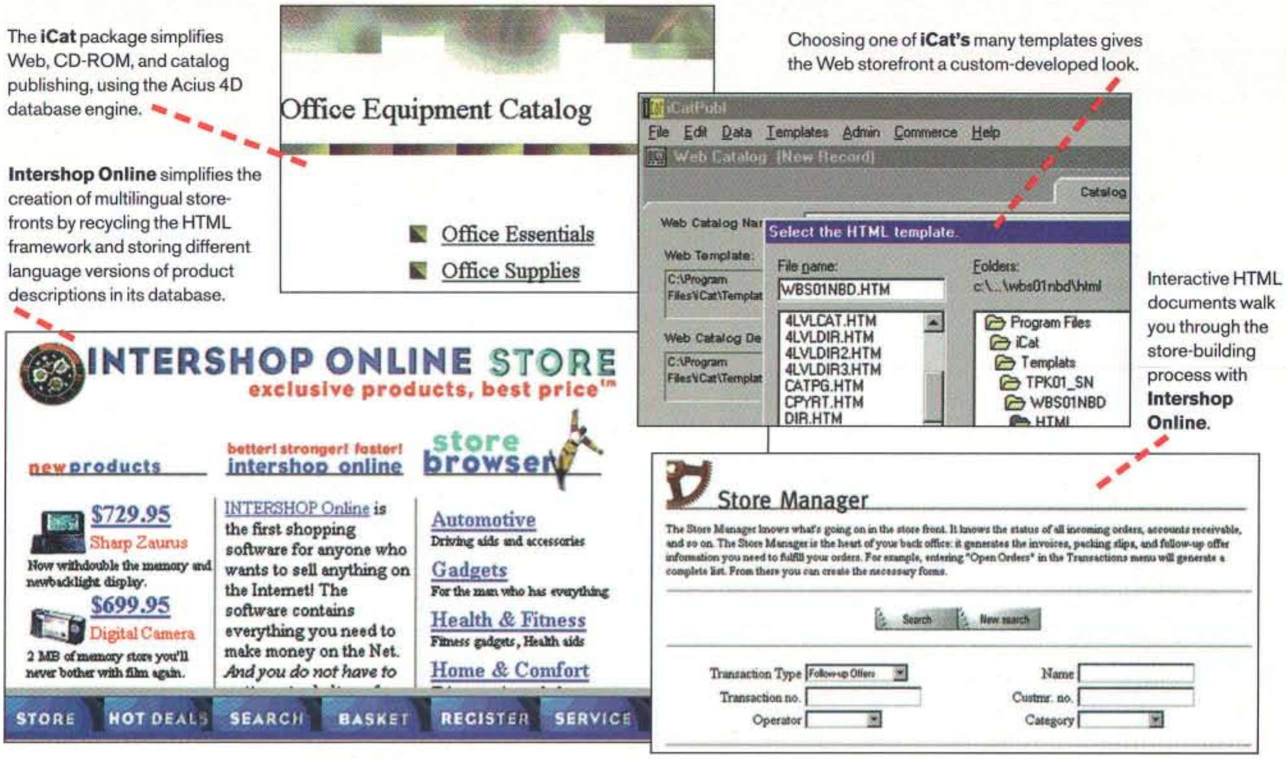
Third-party services such as CyberCash (see the Tech Focus on page 138) and VeriFone are offering secure credit-card services that verify a customer as a cardholder and send credit authorization to the merchant. This method relieves the merchant of responsibility for maintaining and securing credit-card numbers, while assuring that the cardholder is indeed the one making the purchase. All three storefront products support CyberCash as a secure payment method, as well as SSL and S-HTTP.

Some companies are also setting up shipping and tax-calculation tie-in products to assist in automating the transaction. For example, Taxware International offers sales-tax verification via a database of tax jurisdictions keyed by ZIP code.

Servers at Your Service

You can't have a Web store without a Web server, but not everyone has the time to shop around, install, and manage a separate Web-server product. For convenience, all three storefront packages integrate a Web server into the package, but they also make it possible to set up shop using third-party servers such as Microsoft's Internet Information Server (IIS) or Netscape's Enterprise Server.

A Web-browsing shopper experiences storefronts simply as Web sites whose sole purpose is selling products. Generally, the store is structured hierarchically, with the


The **iCat** package simplifies Web, CD-ROM, and catalog publishing, using the Acius 4D database engine.

Office Equipment Catalog

Office Essentials

Office Supplies

Choosing one of **iCat's** many templates gives the Web storefront a custom-developed look.

iCatPubl

Web Catalog (New Record)

Web Catalog Nar

Web Template: C:\Program Files\iCat\Templat

Web Catalog De C:\Program Files\iCat\Templat

Select the HTML template.

File name: WBS01NBD.HTM

4LVLCAT.HTM
4LVLDIR.HTM
4LVLDIR2.HTM
4LVLDIR3.HTM
CATPG.HTM
CPYRT.HTM
DIR.HTM

Folders: c:\...\wbs01nbd\html

Program Files
  iCat
    Templats
      TPK01_SN
        WBS01NBD
          HTML

Intershop Online simplifies the creation of multilingual storefronts by recycling the HTML framework and storing different language versions of product descriptions in its database.

INTERSHOP ONLINE STORE
exclusive products, best price™

new products

$729.95 Sharp Zaurus
Now with double the memory and new backlight display.

$699.95 Digital Camera
2 MB of memory store you'll never bother with film again.

better! stronger! faster!
intershop online

INTERSHOP Online is the first shopping software for anyone who wants to sell anything on the Internet! The software contains everything you need to make money on the Net. *And you do not have to*

store browser

Automotive
Driving aids and accessories

Gadgets
For the man who has everything

Health & Fitness
Fitness gadgets, Health aids

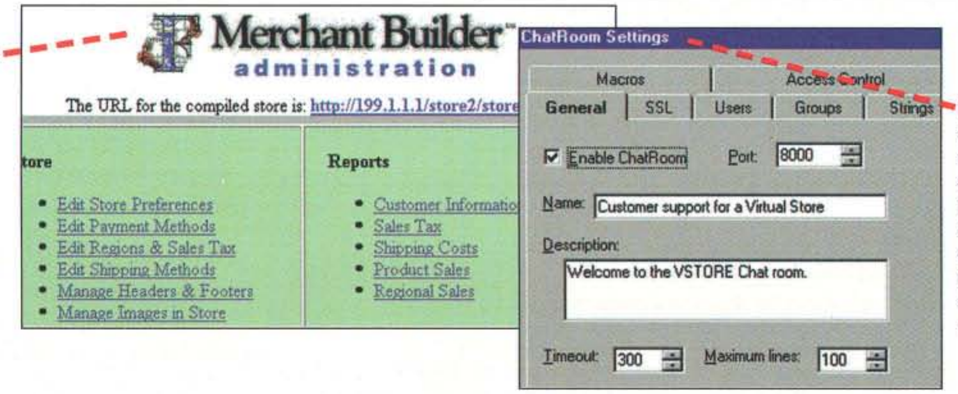
Home & Comfort

Interactive HTML documents walk you through the store-building process with **Intershop Online.**

Store Manager

The Store Manager knows what's going on in the store front. It knows the status of all incoming orders, accounts receivable, and so on. The Store Manager is the heart of your back office: it generates the invoices, packing slips, and follow-up offer information you need to fulfill your orders. For example, entering "Open Orders" in the Transactions menu will generate a complete list. From there you can create the necessary forms.

Transaction Type: Follow-up Offers
Transaction no.:
Operator:
Name:
Custmr. no.:
Category:


The Internet Factory's **Merchant Builder** "compiles" stores, minimizing performance hits from frequent database queries.

Merchant Builder™
administration

The URL for the compiled store is: http://199.1.1.1/store2/store

tore
- Edit Store Preferences
- Edit Payment Methods
- Edit Regions & Sales Tax
- Edit Shipping Methods
- Manage Headers & Footers
- Manage Images in Store

Reports
- Customer Informatio
- Sales Tax
- Shipping Costs
- Product Sales
- Regional Sales

ChatRoom Settings

☑ Enable ChatRoom
Port: 8000
Name: Customer support for a Virtual Store
Description: Welcome to the VSTORE Chat room.
Timeout: 300
Maximum lines: 100

Merchant Builder supports chat rooms, enabling storefronts with informal interaction rooms, direct customer support, or encrypted one-to-one discussions using SSL.

To differentiate itself from competitors, each storefront package combines its database and HTML-based front-end modules in unique ways.

home page acting as the point of entry. Graphical and textual links lead potential customers into the various screens of the site. Just as real stores are divided into departments by product category, you can design virtual stores with product category screens to make it easy to locate products. Instead of asking a clerk how to find a given product, the customer can query the product database. All three products offer predesigned storefronts and other templates, such as virtual shopping carts, to keep track of what a shopper buys and keep a running tally during each "visit" to the store.

There's not much point in having a store if you can't stock it with products. Web storefronts use database services to keep product information up to date and easy to get at. All the storefront products tested for this report link to databases to store and retrieve product, customer, and order information. You manage product information with either special administration forms in the database server or administrative Hypertext Markup Language (HTML) templates.

Danger: Construction Ahead

We found three prerequisites to setting up and running a Web storefront:

- *Windows NT Server 4.0.* It's just plain easier to use than version 3.5x, and because it includes IIS, it's that much more convenient. Before installing any Web-storefront package, however, you should know how to start and stop NT services, set up TCP/IP networking, configure and administer IIS, and administer security services in both NT and IIS.

- *ODBC and database servers.* Two of the storefront packages tested install and configure Open Database Connectivity (ODBC) access on installation. While the iCat package lacks ODBC support at the time of this writing, it's expected for the release in February. Although installation in the other packages is automated,

TECH FOCUS DATA STORAGE

Secure Internet Credit-Card Processing

Security continues to be the fly in the Internet commerce ointment. Secure protocols such as Secure Sockets Layer (SSL) and S-HTTP can protect credit-card data as it passes over the Internet between the consumer and the merchant. However, they do nothing to ensure that the merchant accepts payments only from the authorized cardholder or to protect consumers against theft of decrypted credit-card numbers.

Ideally, order information, confirmation, and charge approvals are all digitally signed by the entities generating them. Encrypting all the transaction messages adds protection from prying eyes. While Secure Electronic Transaction (SET) is designed to satisfy merchants, consumers, and especially the credit-card issuers that transactions are handled securely, lack of a firm specification has hindered efforts to implement it (though IBM, MasterCard, and Danish Payment Systems began live tests of SET in December 1996).

For those who couldn't wait, CyberCash began secure credit-card transactions in April 1995, using a combination of digital signatures and public-key encryption. All three of the storefront packages support CyberCash, which will change from its own protocol (documented in RFC 1898) to SET once the specification is in place.

The credit-card purchase process using CyberCash goes like this:

1. **The consumer decides to make a purchase from a Web merchant's store, based on transaction information provided by the merchant.**
2. **The consumer clicks on a Pay button, launching the CyberCash digital wallet, which prompts for a choice of credit card. The transaction information is digitally signed by the consumer's wallet, encrypted, and sent to the merchant.**
3. **The merchant server signs, encrypts, and forwards the transaction information to the CyberCash server. Credit-card numbers are encrypted with the CyberCash public key, so merchants never have to handle them directly.**
4. **The CyberCash server decrypts and certifies the transaction data and forwards it through a private network to the merchant's bank for authorization.**
5. **The merchant's bank processes the charge automatically. The bank then returns an approval or denial to CyberCash, which passes it on to the merchant. Finally, the merchant passes it on to the consumer.**

Most transactions take fewer than 20 seconds. CyberCash also offers the CyberCoin service for small transactions (under $10) linked to a consumer's checking account.

we recommend that you have a working knowledge of whatever database-server software you'll be managing the store with.

- *HTML*. You can't make omelets without breaking some eggs, and you can't build a Web site without putting together some HTML. The good news is that these storefront packages require only the most basic knowledge of HTML, though more sophisticated customization requires more HTML coding and design experience.

Choosing Web-storefront software ultimately comes down to a decision about features and how they will help solve your store's particular problems. Therefore, specifying storefront requirements up front is the most important part of your selection process.

iCat Electronic Commerce Suite 2.1.2

As its name implies, iCat is a catalog/storefront creation tool for the Internet. The suite includes iCat Commerce Publisher (a catalog development and administration module), iCat Commerce Exchange (for order processing), and iCat Commerce Player (CD-ROM catalog creation).

ICat is the only product in the evaluation that supports the creation of both CD-ROM- and Internet-based catalogs. It comes with the widest array of HTML templates for choosing how your storefront/catalog will appear to shoppers. It is also the only product that runs on the Mac, as well as various flavors of Unix and NT.

With a solid documentation-and-tutorial package, iCat would have been easier to use if it allowed remote administration through the standard Web-browser interface—an improvement due in the February update. The company says that it will also fix the lack of ODBC support in the February release. For its database services, iCat includes the single-user version of Acius's 4D database engine, binding all administration and development work to the server itself. Remote storefront management over a network means buying Acius's 4D Server package.

Intershop Online 1.1.4

Just as in real life, managing things such as inventory, sales, accounts, and suppliers in a Web store can be a hassle. The better your database tools, the easier that task is. Intershop Online comes with ODBC support as well as Sybase's SQL database server 11, which explains not only its higher price tag but its higher scores for ease of use and versatility. With a strong set of back-office functions and built-in manager templates for administering catalog/storefront, product, order, inventory, supplier, and customer functions, Intershop Online eases

WEB STOREFRONTS

BEST OVERALL

Intershop Online 1.1.4

Strong database features and administration templates make this a versatile, easy-to-use program.

INTERSHOP ONLINE STORE
exclusive products, best price™

	PRICE	TECHNOLOGY	IMPLEMENTATION	EASE OF USE	OVERALL RATING
Intershop Online 1.1.4	**$4995**	★★★★	★★★★	★★★	★★★★
iCat Electronic Commerce Suite 2.1.2	$1495	★★★★	★★★	★★★	★★★
Merchant Builder 2.0	$1495	★★★★	★★★	★★★	★★★

★★★★★ Outstanding ★★★★ Very Good ★★★ Good ★★ Fair ★ Poor day-to-day management of the Web store.

The basic store template is substantial and comes with extra functions such as a discount mechanism that lets the store manager automatically reduce price tags. The current product supports applying price discounts on a time basis. The next version will feature dynamic promotions based on customer information. NetConsult plans to release it this spring. This is a powerful feature, and the other companies also plan to add it to their programs.

Intershop Online is also the only product that can create storefronts in four languages: English, French, German, and Norwegian. You only have to rewrite the copy in each language; the database schema remains the same. The admin mode lets you choose a language from a pop-up menu, and the copy for that language is stored in one part of the database. The designer doesn't fiddle with where the HTML and data files for each language are stored, and the user simply clicks on a button to toggle between languages.

Secure remote administration via a Web browser and strong sales analysis and reporting functions round out the package. Though Intershop Online makes a strong showing, it is not perfect. Installation under NT is marred by a seeming bias toward version 3.5x and against version 4.0. Also, priced at $4995 for NT and $7995 for various Unix flavors, Intershop Online may be too costly a program for shoestring operators, but it does include the Sybase SQL database server.

Merchant Builder 2.0

Merchant Builder offers less in the area of predesigned storefront options than the other programs, but its Web server, Commerce Builder, supports chat rooms as well as standard Internet services. Also included is the Internet Factory's SMX command language and sample code for adding Java applets or ActiveX controls to storefronts.

Merchant Builder lacks its own full-fledged database server. Instead, it uses a Microsoft Access database that you can populate with your own data. You design stores so that they can be "compiled" to minimize the amount of traffic to and from the database. Alternatively, you can hook up the storefront to any ODBC-compliant database for better performance.

The Site Magic development tool from the Internet Factory provides the basic building blocks for and comes with Merchant Builder. Its SMX language includes

FEATURES

	iCat Electronic Commerce Suite	Intershop Online	Merchant Builder
CPU, OS MEMORY REQUIREMENTS			
Minimum CPU for Windows NT	486	Pentium 100	486 or Alpha
Windows NT	✓	✓	✓
Windows 95	(A)		(A)
Solaris	✓	✓	
HP-UX	✓	✓	
AIX	✓	✓	
Mac OS 7.x	✓		
RAM for NT (MB)	16	64	32
Disk space for NT (MB)	(B)	200	15
PAYMENT SERVICE SUPPORT			
Checkfree support	✓		
FirstVirtual support	✓		
CyberCash	✓	✓	✓
SECURITY			
SSL 2.0	✓	✓	✓
SSL 3.0		✓	
SET support	✓	✓	✓
DATABASE			
Database-server software included	✓	✓	
ODBC support		✓	✓
Import database files	✓	✓	✓
Export database files	✓	✓	✓
Supports SQL		✓	✓
Administration via Web browser		✓	✓
Number of concurrent DB users	1	Unlimited	N/A
WEB PUBLISHING			
Web-server software included	✓	✓	✓
Supports third-party Web servers	✓	✓	✓
Support for HTML frames, tables, and template language extension	✓	✓	✓
Incorporate text, graphics, audio, video, and PDF support files	4	4	(C)
View store/catalog hierarchy	✓	✓	
Number of storefront/catalog templates	(D)	3	1
Product templates	✓	✓	✓
E-mail templates	✓	✓	✓
SHOPPING AIDS			
Virtual shopping cart	✓	✓	✓
E-mail order verification	✓	✓	✓
Price calculator	✓	✓	✓
BUSINESS MANAGEMENT			
Mall/storefront/catalog creation	✓	✓	✓
Invoices		✓	✓
Orders	✓	✓	✓
Shipment tracking	✓	✓	✓
Purchasing/supplier		✓	✓
Inventory		✓	✓
Customers	✓	✓	✓
SALES MANAGEMENT			
User-created promotions	✓	✓	✓
On-the-fly discounts		✓	
Time/promotion-based discounts		✓	
Sales reports (statistical database reports)	(E)	✓	✓
Sales graphs	(E)	✓	
MISCELLANEOUS FEATURES			
Distribute Web store via CD-ROM	✓		
Scripting/programming language	✓	Perlscript	✓
Supports Java, ActiveX, Perl, Visual Basic, and CGI	✓	✓	✓
Chat rooms			✓
Multilingual support		✓	

(A) Will run on Windows 95 but recommended for site development rather than as a Web server.

(B) Single-user version requires 15 MB of disk space for initial installation. Multiuser version requires Acius 4D Server (additional cost) and additional disk space.

(C) Site-administration tools allow the adding of text and graphics. To add other media requires user programming.

(D) Product ships with 300 templates that are broken into the categories of catalog, product, e-mail, payment service, etc.

(E) User can create reports using the database report writer.

N/A = not applicable.

High-End Commerce Servers

Microsoft, Netscape, and Open Market all offer commerce-enabling products targeted at systems integrators, commerce service providers, and large retail companies. Unlike the storefront software evaluated for this report, these products require the skill sets of professional Web-site builders. These programs provide the tools for Web-development firms and their large clients to build commerce technologies on the Web. These products are not necessarily easy to use—and may require teams of programmers and designers to fully deploy—but the results reflect the extra expense in robustness and scalability.

Microsoft Merchant Server

Merchant Server straddles the market niche between the storefront products evaluated in this report and the higher-end solutions from Netscape and Open Market. At $14,995 for the software and $3495 for each store site you create with the software, this package is too costly to be an entry-level product, and the documentation is clearly meant for Webmasters. There are no wizards or step-by-step dialog boxes to guide you through store development—you need to use Frontpage for that. All product documentation, which covers such topics as installation, building a store, administration, system architecture, order processing, security, and staging the development cycle, comes on the distribution CD in Microsoft Word and Hypertext Markup Language (HTML) format.

Merchant Server relies heavily on Microsoft products, running only on Windows NT with the Internet Information Server (IIS). The starter stores use Microsoft SQL Server as the database server, but it can hook up to any Open Database Connectivity (ODBC) database.

Netscape Merchant System

Besides its popular Internet servers, Netscape also offers the Netscape Merchant System for complete retail management services. Pricing starts at around $60,000 and can escalate sharply depending on how much help is necessary to implement all the desired features. For the money, though, Web merchants can display thousands of products in a catalog, handle hundreds of simultaneous transactions, and integrate with legacy database systems for inventory, orders, and fulfillment. You use a staging server to develop the Web store, while product offerings migrate to the Merchant Server and a separate Transaction Server handles orders.

Merchant System integrates powerful merchandising capabilities, including product search, promotional discount support, flexible pricing, dynamic displays, and multimedia integration capabilities—everything you need to run a merchant site.

First Data processes payments, and the system integrates with Taxware's sales-tax computation engine as well as Netscape's other high-end product, Netscape Publishing System, which lets publishers create subscription-based publications. Merchant System is available for Sun Solaris and Silicon Graphics Irix, with other Unix versions expected this spring.

Open Market OM-Transact

Open Market is in the business of supplying industrial-strength commerce software, with an emphasis on back-office infrastructure, for high-volume Web merchants. Corporate clients can license OM-Transact for $250,000, which, added to the cost of building the actual Web site and catalog databases, puts it out of reach of small Web merchants.

OM-Transact provides a complete back-office infrastructure for secure Internet commerce and supports secure payment, order management, transaction processing, and customer service for high-volume transaction environments. As a backbone Internet commerce offering, it works in conjunction with Web-site and catalog-development tools such as those available from Cadis, Saqqara, and Bluestone, all of which are Open Market software partners, as is the iCat catalog product. OM-Transact runs on major Unix platforms—those from Sun, Silicon Graphics, Stratus, and Hewlett-Packard.

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database access along with Internet- and Web-based functions, and it simplifies building customized store applications. Merchant Builder is available only for NT, though you can administer it remotely through a standard Web browser.

Merchant Builder's chat service can support an open, informal forum for customers, as well as SSL-secured one-to-one conversations. Access to groups can also be controlled by memberships that you administer through the server.

Picking a Winner

Building on the Web can be as costly as building in the real world: It's not unusual for companies to spend hundreds of thousands for a Web storefront, once costs for hardware, software, network expenses, consulting, and content creation are tallied. Picking the right software for your Web store means deciding which features and functions are "must haves" and which are superfluous; focusing on software cost alone could be counterproductive. B

PRODUCT INFORMATION

iCat Electronic Commerce Suite 2.1.2
$1495
iCat Corp.
Seattle, WA
(206) 623-0977
fax: (800) 558-4228
http://www.icat.com
Circle 1033 on Inquiry Card.

Intershop Online 1.1.4
$4995
NetConsult Communications, Inc.
Burlingame, CA
(800) 736-5197
(415) 373-1530
fax: (415) 373-1536
http://www.netconsult.com
Circle 1034 on Inquiry Card.

Merchant Builder 2.0
$1495
The Internet Factory, Inc.
Pleasanton, CA
(510) 426-7763
fax: (510) 426-9538
http://www.ifact.com
Circle 1035 on Inquiry Card.

Merchant Server
$14,995
Microsoft Corp.
Redmond, WA
(206) 882-8080
http://www.microsoft.com/merchant
Circle 1036 on Inquiry Card.

Netscape Merchant System
approximately $60,000 base price
Netscape Communications Corp.
Mountain View, CA
(415) 937-3777
http://home.netscape.com/
Circle 1037 on Inquiry Card.

OM-Transact
$250,000 base price
Open Market, Inc.
Cambridge, MA
(617) 949-7000
http://www.openmarket.com/
Circle 1038 on Inquiry Card.

David Seachrist has tested all major categories of general business software at NSTL for 10 years. You can reach him by sending e-mail to **dseachrist@prodigy.com**.

Evaluations in this report represent the judgment of BYTE editors, based in part on extensive tests conducted by NSTL, Inc., as documented in a recent issue of its monthly Software Digest. *To purchase a copy of that report, with NSTL's own evaluations and data, contact NSTL at 625 Ridge Pike, Conshohocken, PA 19428; (610) 941-9600; fax (610) 941-9950; on the Internet, editors@nstl.com. For a subscription, call (800) 257-9402. BYTE magazine and NSTL are both operating units of The McGraw-Hill Companies, Inc.*

We test development software for a variety of very portable systems. By Steve Mann and Rick Grehan

Hand-Held Development Options

Hand-held systems use leading-edge technologies in hardware, operating systems, object-oriented frameworks, and development tools. For someone just starting out doing hand-held development, that can be a lot to digest. You need to worry about power management, timers, small screens, new user interface paradigms, low-level memory management (a skill that will, unfortunately, probably never be obsolete), and much more. In addition, you need to get used to a new type of development cycle: code, compile, simulate, and debug, followed (eventually) by code, compile, download, remotely debug.

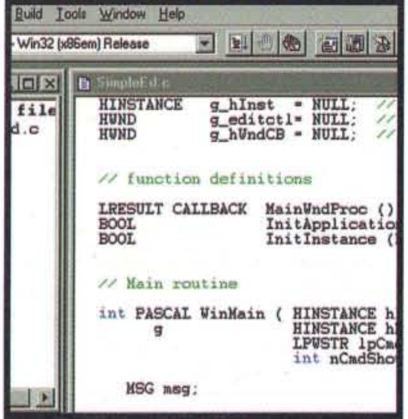
Development packages for hand-held systems are remarkably powerful. They can relieve much of the burden of dealing with a target platform so foreign to programmers who have become familiar with multimegabyte memory and gigabyte hard disks. In addition, many hand-held development environments are well on their way to incorporating the visual development features found in desktop packages like Visual Basic.

Tough Crowd

In this roundup, we explore development packages for five families of hand-held systems. We say "families" because the ranks of hand-held systems are growing daily as manufacturers extend and add product lines. Furthermore, some of the packages we review serve multiple hardware targets; for example, you can use the Windows CE software development kit (SDK) from Microsoft to develop for the Casio Cassiopeia, the Compaq PC Companion, the Hitachi Handheld PC, the NEC MobilePro HPC, the Philips Velo (reviewed on page 46), and more Windows CE hand-helds as they appear.

Like Microsoft, Geoworks and Metrowerks are not in the business of manufacturing hand-held hardware. Geoworks purveys its GEOS operating system and development tools—available on hand-helds such as Hewlett-Packard's OmniGo 100 and 120 and Nokia's 9000 Communicator. Metrowerks, well known for its CodeWarrior compiler, has extended that compiler for developing Palm OS applications for the U.S. Robotics Pilot (see our review, "Multiplatform CodeWarrior," January BYTE, page 47). And Psion not only manufactures its own

WINDOWS CE

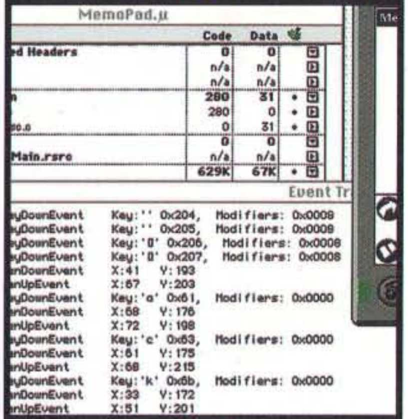


```
HINSTANCE   g_hInst  = NULL;  //
HWND        g_editctl= NULL;  //
HWND        g_hWndCB = NULL;  //

// function definitions

LRESULT CALLBACK  MainWndProc ()
BOOL              InitApplicatio
BOOL              InitInstance (

// Main routine

int PASCAL WinMain ( HINSTANCE h
      g              HINSTANCE h
                     LPWSTR lpCm
                     int nCmdSho

   MSG msg;
```

RATINGS

TECHNOLOGY	★★★★
IMPLEMENTATION	★★★★

PILOT

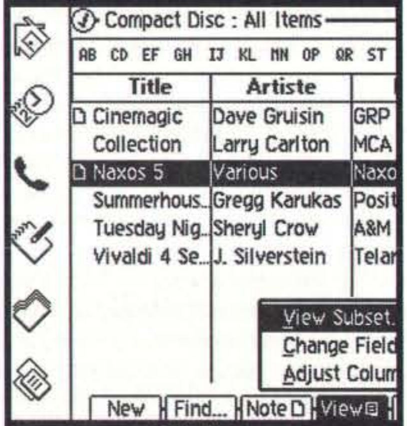


```
yDownEvent   Key:'' 0x204,  Modifiers: 0x0008
yDownEvent   Key:'' 0x205,  Modifiers: 0x0008
yDownEvent   Key:'0' 0x206,  Modifiers: 0x0008
yDownEvent   Key:'0' 0x207,  Modifiers: 0x0008
nDownEvent   X:41   Y:193
nUpEvent     X:67   Y:203
yDownEvent   Key:'a' 0x61,  Modifiers: 0x0000
nDownEvent   X:68   Y:176
nUpEvent     X:72   Y:198
yDownEvent   Key:'c' 0x63,  Modifiers: 0x0000
nDownEvent   X:61   Y:175
nUpEvent     X:68   Y:215
yDownEvent   Key:'k' 0x6b,  Modifiers: 0x0000
nDownEvent   X:33   Y:172
nUpEvent     X:51   Y:201
```

RATINGS

TECHNOLOGY	★★★★
IMPLEMENTATION	★★★★

GEOS

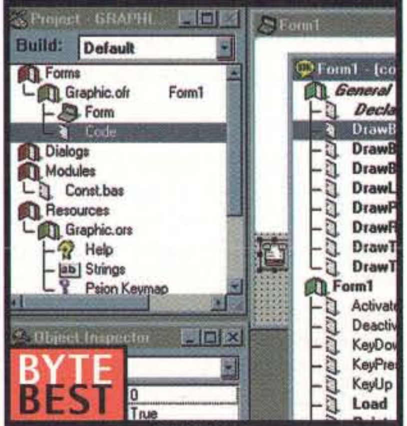


Title	Artiste	
Cinemagic	Dave Gruisin	GRP
Collection	Larry Carlton	MCA
Naxos 5	Various	Naxo
Summerhous..	Gregg Karukas	Posit
Tuesday Nig..	Sheryl Crow	A&M
Vivaldi 4 Se..	J. Silverstein	Telar

RATINGS

TECHNOLOGY	★★★★
IMPLEMENTATION	★★

PSION



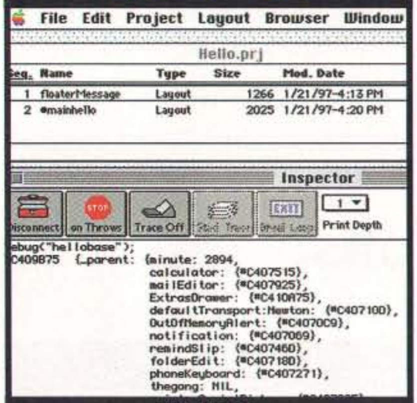
BYTE BEST

RATINGS

TECHNOLOGY	★★★★
IMPLEMENTATION	★★★★★

hand-held systems, such as the Series 3a, 3c, and Workabout, it also offers several development packages for those systems.

MESSAGEPAD



Hello.prj

Seq.	Name	Type	Size	Mod. Date
1	floaterMessage	Layout	1266	1/21/97-4:13 PM
2	•mainhello	Layout	2025	1/21/97-4:20 PM

```
ebug("hellobase");
C409875  {_parent: {minute: 2894,
                    calculator: {#C407515},
                    mailEditor: {#C407925},
                    ExtrasDrawer: {#C410A75},
                    defaultTransport:Newton: {#C40710D},
                    OutOfMemoryAlert: {#C4070C9},
                    notification: {#C407069},
                    remindSlip: {#C40746D},
                    folderEdit: {#C40718D},
                    phoneKeyboard: {#C407271},
                    thegong: NIL,
```

RATINGS

TECHNOLOGY	★ ★ ★ ★ ★
IMPLEMENTATION	★ ★ ★ ★

Windows CE

ADVANTAGES:

+ Uses familiar state-of-the-art Windows tools and APIs
+ Lets you do most development using the supplied x86 emulator

DISADVANTAGE:

– Not totally Win32-compatible.

Windows CE is Microsoft's new operating system for hand-held PCs (HPCs). The company has defined a reference platform for a device that fits in your pocket, weighs less than a pound, has a keyboard, is priced under $500, has no-brainer desktop data synchronization, and is easy to learn and use. Win CE, a scaled-down version of 32-bit Windows, is the component that delivers the last requirement. When you turn on a Win CE device it looks like gray-scale Windows 95 on a small (one-half VGA) LCD screen.

Thanks to its Windows heritage, the CE development environment uses familiar Windows development tools. You need to have Microsoft's Visual C++ 4.0 (not the latest 4.2 version) and the Windows CE SDK, all running on a Windows NT 4.0 system with at least 60 MB of free disk space. The only cabling you need—for purposes of final debugging—is the serial cable that's supplied with each HPC.

The Win CE OS uses about half of the 32-bit Windows APIs, plus a few extensions specifically for Windows CE:

- Support for multithreaded, multitasking applications
- Memory-management messages for handling low-memory situations
- A nonvolatile object store that contains registry, program data, and database files
- Command bars: a GUI region at the top of a Windows CE window that contains buttons, combo boxes, menu bars, and other UI items
- RAPI (Remote API): a set of functions for executing various CE functions, such as registry-access commands, on the HPC, from the desktop
- Notifications: timed events for alerting users and for timed program-to-program communication

Win CE also uses a few extensions specific to CE. The two most unique parts of the architecture are the object store and command bars. The registry (similar to the Win 95 registry), executable programs, and standard stream-oriented data files are all stored in the object store. Programmers can also use a database, a set of records where each record is a collection of one or more properties of type signed or unsigned integer, string, 64-bit date/time values, or a binary large object (BLOB).

Command bars are the primary UI feature separating Windows CE from Windows 95. Because screen real estate is precious, Microsoft mandates that you can have only one set of primary UI controls at the top of an application's single window. You manage these controls just as you do other Windows controls: by intercepting and responding to messages in your main event loop.

Creating and debugging Win CE code is virtually identical to creating desktop code. You build a project, add source code files and resources, select a target, and compile. You can target the MIPS R4000, Hitachi SH3, and x86 desktop emulator. If you select the MIPS or SH targets, the integrated development environment (IDE) attempts to download the executable to an HPC connected to the serial port. If you choose the emulator, it transfers the executable to the emulator's object store and launches the emulator.

At the time of this writing, the Windows CE SDK was in beta, with availability and price yet to be determined.

GEOS

ADVANTAGES:

+ Patented hardware-independent UI technology
+ Customizable debugger

DISADVANTAGES:

– Overly complex, delicate tools
– Lacks an integrated development environment (IDE)

GEOS is an operating system designed for a variety of personal devices, from hand-held computers like the Hewlett-Packard OmniGo series to smart phones like the Nokia 9000. Geoworks was one of the first companies to design an object-oriented OS specifically for small devices. The company's early entry into this market is reflected in the maturity and depth of the OS. GEOS is a multithreaded, multitasking architecture that can fit into a small memory footprint. It's a dynamic, OO architecture with a rich set of base classes for UI components, messaging, charting, graphics, and database objects; several types of programmer-controllable virtual memory; and even high-level objects like a spreadsheet.

Setting up a GEOS development environment can be a bit complicated. You need a host and a target system, connected by a null modem cable. Geoworks recommends the following:

- Host: A 486 or higher DOS system with at least 8 MB of RAM and 200 MB of free disk space
- Target: Any PC-compatible DOS machine (a 386 is recommended) with at least 10 MB of free disk space

In addition, eventually you need a real device for final testing.

The GEOS SDK is a set of discrete tools—C preprocessor, linker, make facility, upload and download utilities, assembler, and symbolic debugger—that can be used from the DOS command line (there is no IDE). Also included are UI and localization tools that run under GEOS 2.0 for the desktop. You also need Borland's C/C++ compiler, version 3.1 or higher.

Most GEOS applications are written in C using GEOS-specific source file definitions for all program classes and methods and standard C for normal processing modules. One of the major benefits of the GEOS OO architecture is its patented, flexible user interface, where you define UI

TECH FOCUS TINY OO

Forced Objects

Psion's C development package and Geoworks GEOS SDK attempt a difficult trick: implementing an object-oriented environment atop the nonobject-oriented C language. Both systems require that a project include class-definition files—category files on the Psion, GOC (GEOS C) files in GEOS. After preprocessing, these definition files are merged (either before or after linking, depending on the platform) with C source code files that implement the classes' behavior.

GEOS uses prepended keywords to identify classes, messages, objects, and instance data. For instance, you define a class and its messages with the following statements:

```
@class <classname>, <superclass>;
@message void <message1>;
@message void <message2>;
@endc <classname>, <classattributes>;
```

Psion's overloading scheme allows a subclass to override its parent's methods. You can't specify this within the C language, which has no concept of class or overriding. The preprocessor recognizes the method keyword preceding a function. In that case, the programmer must give the function's name the form `<classname>_<methodname>`, which associates method with class (the class having been defined in the category file) while satisfying C's requirement that each function name be unique.

objects in general terms like their preferred screen orientation and relationship with other UI components. The OS then positions the components based on these hints. You avoid specifying components in pixel terms and get source code that is, theoretically, portable.

After defining your objects, you run them through the preprocessor, then through the Borland compiler (along with your standard C modules), then through the make utility, and then you upload your application to the target machine for debugging. Although the debugger is quite powerful (you can define your own commands using the TCL scripting language), its interface is archaic and the program is not especially bulletproof.

Pilot

ADVANTAGES:

- + On-screen Pilot simulator for fast development turnaround
- + Application structure will be familiar to Mac programmers

DISADVANTAGE:

- – Though you can develop in the CodeWarrior IDE, you must use the MPW command-line environment to create final executables.

The U.S. Robotics Pilot is the smallest of the hand-helds whose development systems we tested. At 4.7 by 3.2 by 0.7 inches, it fits into your shirt pocket. We did our testing with a Pilot 5000, which is equipped with 512 KB of storage. As with the Magic Link, the Pilot's development platform is the Macintosh-hosted CodeWarrior compiler. However, whereas Magic Cap development software is bundled with the CodeWarrior Gold 11 compiler, you need the separate CodeWarrior Pilot software to develop on the Pilot.

When we received our Pilot and the CodeWarrior software, we were concerned about their lacking a means of downloading applications from the Mac to the Pilot. However, the Pilot comes with a docking cradle, attached serial cable, and HotSync software for the PC (an equivalent package will shortly be available for the Mac). Using HotSync not only allows you to update the Pilot's data contents (to-do lists, notepad notes), but it also lets you download new software. Once we had a Pilot application built, we copied it to the PC and used HotSync to install it.

The CodeWarrior Pilot software includes a Pilot simulator. This simulator provides a realistic imitation of a full Pilot hand-held. Once you've got an application ready for testing, you simply compile and execute it in debug mode and the simulator starts up automatically, with your application running. You can use the simulator's various inspection features to watch, for example, the processing of system events as your application executes.

The guts of a Pilot application look much like a typical event-driven Macintosh application written in C. You define an application's visual components using the Mac resource editor, ResEdit (CodeWarrior Pilot arrives with resource extensions that you load into ResEdit for defining Pilot-specific visual controls). This is both a strength and a weakness: If you've done even moderate Macintosh C programming, you'll feel at home in Pilot development; but ResEdit doesn't provide visual development. For example, if you're putting a button in your application, you enter the button's screen coordinates as numeric values. But to see if you got the position right, you have to compile and run the application in the simulator.

Though the debugging side of development on the Pilot is well supported by the simulator, the process cries out for more visual development tools. Let's hope Metrowerks hears those cries.

Psion

ADVANTAGES:

- + Three development environments to choose from
- + Its OVAL language is spitting image of Visual Basic

DISADVANTAGES:

- – C development package is difficult to master
- – Debugging requires cable and target system (there's no on-screen simulator)

Though Psion makes a number of hand-held systems, we examined development tools for the Series 3c, an NEC V30-based system running at 7.36 MHz, with 2 MB of ROM, a complete (though shrunken) QWERTY keyboard, and no stylus. Our unit also had 2 MB of RAM.

You can choose among three routes to build software for the Psion, each with its own language and environment. Least demanding is the Organizer Programming Language (OPL). OPL source code looks like BASIC—the Qbasic bundled with DOS, that is, not Visual Basic. It's easy to master and gives good high-level control of system resources. But as an interpreted language, it suffers performancewise.

Psion also offers a C development package propelled by Topspeed's DOS C compiler. All the associated tools are DOS-based, so the host platform's disk and memory requirements are minimal by today's standards. The accompanying debugger's feature set is extensive (it provides source-level debugging and execution tracing, for example), but its user interface is quirky. It's a multiwindowed debugger, but the window controls are unlike any we've seen.

Psion's Object-based Virtual Application Language (OVAL) is a dead-ringer for Visual Basic. Programmers experienced with VB will be able to dive into OVAL's familiar forms-based development environment without looking twice. Some of the controls available in OVAL are specific to the Psion device. For example, one control allows you to query the status of the battery; another provides access to the Psion's high-speed serial link. Another pair lets you build client/server applications on the Psion machine. The controls provide high-level access to the low-level interprocess communications capabilities of the Psion's built-in operating system.

Whatever development system you choose, you'll need an adapter cable that connects your PC's serial port to the Psion's high-speed serial connector (it runs up to 57 Kbps). This not only lets you transfer programs and data to the Psion but also serves as the means by which the C-based and OVAL development packages' symbolic debuggers control the application being debugged. We got our cable with PsiWin, a software tool that provides an easy means of copying files to and from the Psion hand-held (which is how we downloaded our OPL programs when they were ready for testing).

Psion (our BYTE Best pick) deserves praise for providing a variety of well-engineered development avenues. Our favorite was, of course, OVAL. In fact, we'd like to see something like OVAL for every hand-held system.

MessagePad

ADVANTAGES:

- + Development package is rock-solid.
- + Inspector lets you interact with Newton interpreter on MessagePad.

DISADVANTAGE:

- – NewtonScript takes getting used to

To appreciate software development on the MessagePad, you must appreciate NewtonScript. And to appreciate NewtonScript, you must be willing to come to grips with terms like *proto, slot,* and *soup*, all of which identify important elements of the NewtonScript language. And if you aim to develop software on the MessagePad, you'll have to deal with idiosyncrasies of NewtonScript because NewtonScript shapes the development process.

NewtonScript is an object-oriented OS built atop the concept of a *frame*, which is a data structure that consists of an unordered collection of named *slots*. A slot can hold just about anything: a data value, an array of values, code, or a reference to another frame. The latter instance allows one frame to point to another frame and is the foundation on which NewtonScript erects inheritance.

Frames within the MessagePad's ROM define the fundamental graphical and nongraphical objects that compose a MessagePad application. These frames are called *protos*, and by subclassing protos and overriding the contents of their slots—similar to specifying an object's properties—you build a NewtonScript application.

Fortunately, the Newton Toolkit (NTK) makes this an easier process than it sounds. And as foreign as NewtonScript seems, building an application in the NTK bears a remarkable resemblance to forms-based development of the sort offered by Visual Basic. Development with the NTK is made easier by the integrated debugging tools. Chief among these is the Inspector, which—aided by an adapter cable that connects the Mac's serial port to the MessagePad's—gives access to the MessagePad's machinations. The Inspector lets you download and execute single NewtonScript routines or entire applications. You can set breakpoints, perform a stack trace, examine a frame's slots on-the-fly, and more. (The NTK comes with an adapter cable that connects the Mac to the serial port on the MessagePad.)

The NTK also contains Book Maker software for building digital "books" called NewtonBooks. Though the Book Maker's aim is to deliver readable material, it also lets you include graphics and live controls in each NewtonBook.

As we were completing this article, Apple was finalizing beta versions of a Windows-based NTK. Check the Apple Web site for pricing and availability.

A Hand Up

The small size and apparent simplicity of hand-held systems belie the complexity of building software for such machines. Fortunately, the development tools are up to the task, thanks mainly to crossover technology from the desktop. Pilot's use of Metrowerks CodeWarrior, GEOS's use of the Borland C/C++ compiler, and Win CE's use of Microsoft VC++ are excellent examples of this.

Even if you have great tools, you should plan on investing some time learning about object-oriented systems. Psion, Apple, and GEOS all have rich, deep OO frameworks that require several weeks of serious daily study. After that, you will still need a few months before you can really build bulletproof, commercial-quality software. There are no shortcuts.

One of the biggest challenges for professional developers is figuring out which platform to build products for. No one product has an installed base of more than about 1 million units; most of them have considerably less. You need to be a bit clairvoyant, work hard until one or more of these platforms has a multimillion-unit installed base, and then hope that you picked a front runner. **B**

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*Steve Mann is publisher and editor of Handheld Systems (**http://www.cdpubs.com**). Rick Grehan (**rick_g@bix.com**) is a senior technical editor for BYTE reviews.*

PRODUCT INFORMATION

CodeWarrior Pilot
$299
(PowerPC or 68040 Mac)
Metrowerks
Austin, TX
(512) 873-4700
http://www.metrowerks.com
Circle 1074 on Inquiry Card.

GEOS SDK for OmniGo
$99
Geoworks
Alameda, CA
(800) 436-7735
(510) 814-5846
http://www.geoworks.com
Circle 1077 on Inquiry Card.

Newton Toolkit for Mac
$299
Apple Computer
Cupertino, CA
http://www.apple.com
Circle 1071 on Inquiry Card.

Psion C Development Kit
$100
OPL Development Kit $100
OVAL Development Kit $100
Psion
Concord, MA
(800) 997-7466
http://www.psion.com
Circle 1068 on Inquiry Card.

Visual C++ 4.0
$99 (standard edition)
Windows CE SDK
price not available at press time
(Windows 95 or NT)
Microsoft
Redmond, WA
(800) 426-9400
http://www.microsoft.com/wince
Circle 1076 on Inquiry Card.

Review

Development Software

The latest release of the Java Development Kit, version 1.1, charts the future of the language. ***By Rick Grehan***

Java Development Kit, Take Two

Although you certainly can use Sun's Java Development Kit (JDK) to construct Java applets and applications, that has never been its main purpose. The JDK is, first and foremost, a functioning specification for the Java environment, although it also addresses much in the Java world that has nothing to do with Java as a language.

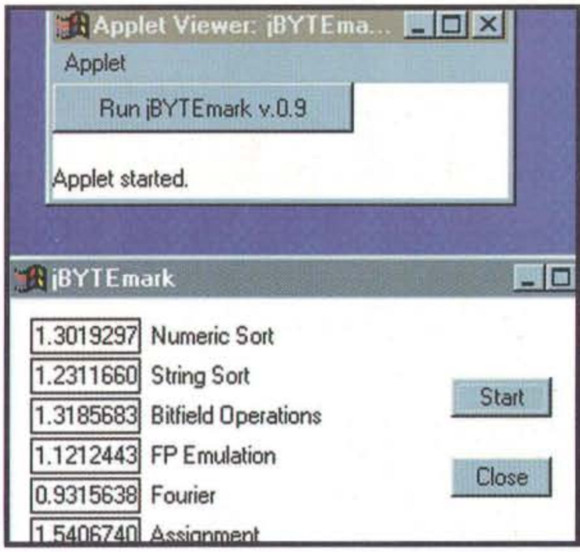
I recently tried the much-anticipated beta version of the latest JDK, version 1.1, which is available for downloading from http://java.sun.com. I examined not so much the quality of the supplied development tools but rather the new and improved APIs and their accompanying specifications.

Function over Form

The full JDK consists of two downloads. One is an archived file of all the command-line development tools and runtime support files; the other is the documentation. As of this writing, JDK 1.1 is available for the Solaris and Windows 95/NT platforms. Other platforms will certainly be available soon.

The JDK comes with all the tools you need to build and run Java applets and applications. You get a compiler, a debugger, Java VM, an applet viewer, and other accessory executables that support some of the new security features and the Java archive file format (JAR, explained later). The JDK also includes all the necessary Java class files.

But the JDK is not a visual development system, like Microsoft's J++ and Symantec's Café, nor is it supposed to be. Rather, it's a hands-on laboratory for the evolving Java environment. It is simultaneously robust and primitive—robust in the sense that you can construct and run full-blown and ready-to-distribute Java applets and applications, and primitive in the sense that the package's tools all run from the command line. (That includes the debugger—and there are few things that are more primitive than a command-line debugger.)



```
Applet started.
```

```
1.3019297  Numeric Sort
1.2311660  String Sort
1.3185683  Bitfield Operations
1.1212443  FP Emulation
0.9315638  Fourier
1.5406740  Assignment
```

It's not pretty, but it works: JDK 1.1 compiles our jBYTEmark suite without a hiccup.

Java Development Kit 1.1
Free for noncommercial use
(runs on Windows 95/NT or Solaris)

JavaSoft
(a business unit of Sun Microsystems, Inc.)
Cupertino, CA

(408) 343-1684

http://www.javasoft.com

Circle 976 on Inquiry Card.

New and Improved

The package's list of enhancements and additions is long (see the text box "New in JDK 1.1" on page 146), but some of them stand out as truly significant. Most striking are the changes to the Abstract Windowing Toolkit (AWT), whose Win32 version's internals have been completely rewritten. In addition, the AWT's new event model promises to improve performance as well as help programmers write more-comprehensible code (see the Tech Focus on page 146).

RATINGS	
TECHNOLOGY	★★★★★
IMPLEMENTATION	★★★

The aforementioned Java archive file specification, JAR, spells out the format for bundling an applet's components—classes, images, and sounds—into a single compressed and optionally secure file. (One of the supplied tools builds JAR files.) Because each individual file transfer through HTTP requires its own separate TCP virtual circuit, archiving applet components into a single compressed file means that 1.1-compatible servers will deliver applets to browsers faster.

Java Database Connectivity (JDBC), the documentation for which is a separate file that prints out to a small book, brings Open Database Connectivity (ODBC)–style database access to Java. The JDK's supplied JDBC-ODBC bridge software implements JDBC via ODBC, allowing you to experiment with JDBC using ODBC drivers.

Rounding out the more important additions to this release are new wrapper classes that the Java language should have

New in JDK 1.1

Improved Abstract Windowing Toolkit (AWT)
- Rewritten Win32 version.
- New event model.
- Additional visual classes.

Java archive file format (JAR)
- Packages applet components for fast downloading.
- Can incorporate digital signatures to protect against intentional third-party corruption of JAR file components.
- Based on the PKZip format.

Java Database Connectivity (JDBC)
- Database connectivity specification similar to ODBC.
- JDK includes JDBC-ODBC bridge for building test programs.

Security API
- Classes that support digital signatures, data encryption, and key management.
- Security support in JAR files.

Internationalization
- Objects can be sensitive to language, currency, and so forth.
- Enhanced string class can collate based on language.
- `TextBoundary` class can determine word and sentence boundaries based on language.

Extended Network API
- Sockets are no longer `final` and can easily be extended.
- Exceptions are more accurate.

Remote method invocation (RMI) and object serialization
- With RMI, an object can call another object's methods remotely–on a machine next door or in the next country.
- The object-serialization API can convert an object into a stream of bytes for "beaming" a copy of that object across the network.

Reflection API
- Java applications can gather information about loaded classes at run time.
- Useful for debuggers; necessary for JavaBeans.

had to begin with: wrappers for byte, short, and void primitives. A new numeric class, `bignum`, enables programs to manipulate numbers of arbitrary precision. You can alter the rounding behavior of the `bignum` class, and therefore optimize its precision, depending on whether your requirements are toward scientific or business computing.

Good News and Bad News

Java programmers and users have plenty to be happy about with the release of JDK 1.1. The improvements in the AWT's performance should be apparent to anyone running applets in a 1.1-compatible browser, and the AWT's new event model will make Java developers' lives easier. The inclusion of JDBC is already spurring the appearance of JDBC development systems (e.g., Symantec's Visual Café Pro), and the remote method invocation (RMI) API opens the possibility of distributed Java applications.

Tarnishing the flip side of the coin are the usual corrosives accompanying any software upgrade: Programmers who invested time and mental energy in those elements of Java that are either changing or being eliminated will have to shift some mental gears. Happily, the JDK 1.1 documentation offers some guidelines for upgrading existing source code, and JavaSoft has taken substantial steps toward providing reasonable backward compatibility. For example, the new AWT will continue to support the previous event model. I was able to compile and run BYTE's Java benchmark suite (jBYTEmark) with no problem, even though jBYTEmark was built using the old event model.

By all means, if you have not yet downloaded JDK 1.1, do so (it's free). But recognize it for what it is: not a commercial Java development package, but a source of valuable documentation and a well-engineered testing ground for the next generation of Java programs. ■

Rick Grehan is a senior technical editor for BYTE reviews. You can reach him by sending e-mail to **rick_g@bix.com.**

TECH FOCUS | EVENTS

Inside the Delegation Event Model

JDK 1.1's version of AWT supports a new delegation model for handling events. The old model dealt with events in a hierarchical fashion. The AWT delivered an event to the target component (e.g., an ACTION_EVENT was delivered to the button that was clicked), which either handled the event or repeatedly passed it up the line to the containing objects. Ultimately, either a containing object handled (i.e., consumed) the event, or the event bubbled out the top of the containment hierarchy.

Programmers working in this model built applets with one of two event-handling architectures. In the first, they subclassed each potential target object (button, checkbox, and so forth) and overrode the object's event-catching methods with code that responded appropriately to events. This architecture generated lots of subclasses as objects were individualized to their specific function. In the second architecture, programmers overrode the outermost containing object's `handleEvent` method and dealt with events through an often large and complex `switch` statement.

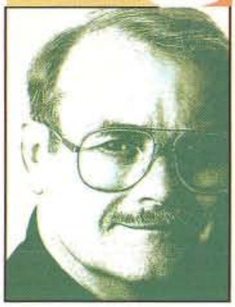
The new delegation model identifies those classes that can produce events (e.g., buttons, checkboxes, and text fields) as sources. Listener objects–those that contain code to respond to events–register themselves with source objects.

Furthermore, listener objects can register themselves according to the kinds of events they can handle. For example, a listener object might register itself to receive only action events (e.g., a button click) and would consequently not be bothered by adjustment events (e.g., changing the maximum value on a scroll bar). When a source object triggers an event, that event is sent to all listener objects that are registered with that source to receive that kind of event.

Because code that handles an event is more directly connected to the event's source, the new model should result in more efficient programs. Additionally, new-model programs should be easier to understand; large, confusing `switch` statements are unnecessary.

Jerry Pournelle

Chaos Manor



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Orchids and Onions Are Blooming

Jerry surveys the chaos and presents the year's User's Choice Awards.

I'm writing this in mid-January. The issue will be dated April, but most of you will get it in March. What this means is that since I stubbornly insist that a year ends in December rather than in time for the January issue, it's time for the 1996 Chaos Manor User's Choice Awards and the annual Orchid and Onion parade. As usual, I will write more than my long-suffering editor will be able to squeeze into the magazine, so those who want it all will have to go to BYTE's Web site. I'll present the awards here; some of the discussion will have to go on the Web site.

The ground rules for my awards are simple: these are products I use and recommend. There's just too much going on in the computer world for me to pretend I know what is best in any absolute sense, but I do know what's good enough and more. In most cases, I give my awards to products that have been the most useful to me in the past year. That said, let's launch right in.

A large Orchid to Cyrix (Richardson, TX, http://www.cyrix.com) for their 6x86-P166 system. I've been using this mini-tower system as my main machine for a couple of months now, and Cyrus has been a little jewel. At the moment, Cyrix is no longer selling machines to end users. Their problems appear to be marketing, not technical. Certainly I've had a lot of success with Cyrus.

Having said that, I must add that if I could get the Gateway 2000 P5-200XL system away from Mrs. Pournelle, I'd probably use it as my main machine. She does more graphics and Web crawling than I do. Besides, for years she's had the slower hand-me-downs, so it's only fair that this year she has the fastest single-processor machine in the house.

Everyone has horror stories about computer companies. Any company doing a lot of business will inevitably have the bad luck to have their most stupid and arrogant employee handle an unusual problem involving a customer who does not understand anything beyond the fact that an expensive new system does not work. That's happened to Gateway 2000, and I think every time it has I've gotten a letter. Fortunately, I get much more mail from satisfied customers; and Gateway 2000 (North Sioux City, SD, http://www.gw2k.com) gets a big Chaos Manor Orchid for producing systems that are consistently cutting-edge useful.

The ground rules are simple: these are the products I use and recommend.

The Chaos Manor Onion of the Year goes to the new trend in do-it-yourself technical support. Companies like Symantec, Diamond Multimedia, and Iomega are hiring what can charitably be described as unaware people to take calls. In theory, they're supposed to screen out the callers who haven't plugged in their computer or who use the CD-ROM drive platform as a cup-holder. In practice, those are the only problems many of them can deal with, but they don't know that.

Sometimes, you can convince them you know more about the problem than they do and get transferred to a person who can actually help. All these companies have some excellent people, but often, before you get to an intelligent person, you'll hang up in disgust. Particularly abysmal is the regular support for DOS and Windows versions of Symantec's Norton Utilities; but in fact, DOS and Windows 3.11 technical support is fast becoming nonexistent for all programs.

Meanwhile, technical support and technical knowledge in most electronics stores have vanished without a trace. Worse, many clerks pretend they know what they're doing, when in reality they don't know a motherboard from a school board.

In fairness, I have to say that this is as much the fault of customers as publishers and storekeepers. The competition has become fierce, and stores that hire knowledgeable clerks find that customers come in, use up lots of clerical time, and then buy the recommended system down the street for 2 percent less.

This has made life easier for gurus. My son Alex reports a great increase in his consulting business, as small-office professionals find that they've wasted half a day buying a system, two more days trying to get it to work without support, and another day exchanging the incompatible equipment and software. This is Pournelle's law at work: if you don't know what you're doing, deal with people who do. In this rapidly changing computer world, it's difficult to know what you're doing and also have time for your regular business. BYTE readers are better off than most people, of course, but most small businesses would be well advised to hire a good consultant for part-time MIS help, preferably someone who's willing to be on call evenings and weekends.

A Chaos Manor Orchid for Novell (Orem, UT, http://www.novell.com). They have excellent and well-organized information on their Web site, with support questions and answers available

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on-line. Their telephone technical support has improved, too. Novell is a good example of the wise use of the Web for technical support. A few other companies have made good use of the Web for dispensing technical support and information, but it's astonishing how bad some of the Web sites are.

A small Onion with a little Orchid attachment for Symantec. As many of you know, I have used Symantec's Norton Commander for years. It's an excellent DOS file management utility, and each revision was an improvement. One of its outstanding features was a battery of file viewers. With one or another of those you could look at *any* files, including command and executable files. The viewers understood many file formats, and when they didn't, they'd still show you *something*. If anyone's wondering why you'd want to look at an executable file, remember that many files have embedded ASCII strings that will show up as plain text; if you're looking at a file made up of lost chains, viewing it can help you decide which file became an orphan. Moreover, Commander 4.0 could look into ZIP and compressed files, and even show some graphics files. It also had a neat little editor that was very handy for working with CONFIG.SYS and WIN.INI.

Then came Windows 95 (Win 95). Commander still worked fine, but it is a DOS program, so the only way it can handle long filenames is by truncating them and putting the tilde in, after which you've lost the real filename, as well as any extended attributes.

For the first year or so after Win 95 came out this was no big problem, but lately it has become one, so I was overjoyed to find out there's a Win 95 Commander. Norton Commander 95 is a stealth product: it was sort of announced in Europe, but Symantec's PR representatives in the U.S. claim it is not available. I managed to get a copy through Symantec's order line, but be prepared: there's an abysmal menu tree followed by a long wait. What I got was an upgrade edition: it says it won't install unless it finds either an older DOS or Windows version on your hard disk.

Alas, what you get isn't the old Commander. Some of the "improvements" aren't, and some of the viewers are gone. So, I've kept Commander 4.0 for the viewers, and I use this for long filenames.

I suppose part of my problem is frustration. I liked the old Commander so

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much that if they'd simply put it out with the ability to handle long filenames, it would have got the User's Choice Award as the Utility of the Year. Sigh.

We're just getting started with graphics. In a week or so, we'll have a new high-end graphics test-bed from Compaq, the first Compaq system ever at Chaos Manor. With the assistance of my graphic artist associate David Em, I'll be doing a lot of graphics work this year. Meanwhile, here are the 1996 User's Choice Awards for graphics.

The User's Choice Award for graphics OS goes to Microsoft Windows NT 4.0, and the User's Choice Award for graphics CPU goes to Intel's (Santa Clara, CA, http://www.intel.com) Pentium Pro. I hadn't expected that. Apple has long dominated the high-end graphics game, but at present, NT is better able to make use of multiple processors. It's also cheaper and easier to build up a super system with 256 MB of RAM, several gigabytes of hard disk space, and 32 MB of video memory. You don't *need* all that to do good graphics, but the more and finer graphics work you do, the more you'll wish you had that much, and NT can handle it.

It is time to comment on Apple's dwindling pool of exclusives. At one time, you had no choice: if you wanted to do serious work in high-end graphics, you paid six figures for a Silicon Graphics system, or you bought the best Mac you could afford. Programs like Equilibrium Technologies' DeBabelizer and Adobe Photoshop were essential, and they were available only for the Mac. That's no longer true. Apple still dominates in text-to-speech software. The Mac is better for video capture. If you want really high-end printed output, Apple has a decided edge.

Most service bureaus that do printing prefer to work with Macs, but again, that's changing. Many places, including some Kinko's, have NT systems now. In short, where Apple used to be the only system for graphics (and at one time for desktop publishing), it has lost that exclusivity, and in many areas isn't even the leading system.

Now Apple needs a new competitive edge; they may have that with the NextStep OS. I've just spent the last couple of days with the Apple and Next Software (Redwood City, CA, http://www.next.com) people, and their enthusiasm is catching.

NextStep has long been one of the richest and easiest-to-use software-development systems in existence, and almost everyone who has used it has hated to go back to any flavor of Mac or Windows systems. I recall Bruce Webster's enthusiasm when he showed me what he was doing with it. While one might dispute Steve Jobs's statement that with NextStep two guys in a garage can quickly create programs with a finished quality that would take far longer for a much larger team of experts working in Windows, there's some truth there. NextStep makes it fairly easy to build applications out of objects; certainly much easier than fighting through most Windows applications builders. Assuming Apple brings this off, they may well attract outside developers.

Apple needs a new competitive edge; they may have that with the NextStep OS.

Apple was saved the first time by VisiCalc. Later, the Mac was saved by desktop publishing systems and then by high-end graphics. In every case, the savior was an outside developer. At MacWorld (San Francisco, January 6 to 10), Apple tried to make it clear that they have learned this lesson. They're trying hard to encourage third-party developers. The purchase of Jobs's Next Software was also a part of Apple's developer-friendly strategy. They even threw a big party for developers at MacWorld.

Anyway, a Chaos Manor Orchid for Apple (Cupertino, CA, http://www.apple.com). They're trying hard, and they've at least made some good moves. I wish them well.

Meanwhile, there's been great improvement in graphics software for NT systems. Adobe Photoshop 4.0 is the indispensable image-manipulation program. It wins a User's Choice Award, although it hardly needs one. Photoshop used to be a Mac-only program, and earlier versions of Photoshop were used in making a number of well-known movies. It's still in use in most studios, only now there are as many NT systems as Macs.

Animation programs: 3D Studio Max for NT from Kinetix, a subsidiary of Autodesk, wins a User's Choice Award for sheer bang for the buck. This has tremendous capability in an economical package, and it's easier to use than some of its rivals. The interface is an enormous improvement over previous versions.

For creating new images, Fractal Design's Expression gets this year's User's Choice Award. This is a program like FreeHand, but we like the interface better. It has many brushes and good palette construction. Recommended.

The User's Choice Award for graphics shareware goes to Thumbs Plus, which does thumbnail sketches of pictures and sounds, making filing and retrieving a great deal easier. It's available on better shareware sites, and if you store a lot of multimedia files, you will need this.

Matrox Graphics' (Dorval, Quebec, Canada, http://www.matrox.com/mga) video product line gets the 1996 Chaos Manor User's Choice Award for video boards. It was a close race—see the Web Exclusive for the competition—but they are the boards to beat.

I also like the $500 Alps MD-2010 Photo-Realistic Color Printer. It gets a User's Choice Award for 1996. Like all color printers of this class it's slow, a minute a page for text and at least twice as long for graphics; but the output is surprisingly good, and it will save you many expensive trips to the print house.

Meanwhile, there are a host of products that merit User's Choice Awards, but I just don't have space here to discuss them at the length they deserve. Many of them I've written about recently, and you'll find more detail in the Web Exclusive part of this month's column on the BYTE Web site.

One reason Web sites will get better is Microsoft Frontpage 97, which gets the User's Choice Award for Web-page design tools. This thing is a little miracle: just sit down and use it. It's very Word-like (no surprise there), and if you can do word processing, you can create Web pages with this. Try it. You'll like it.

Cybermedia earns two User's Choice Awards: one for Oil Change, which can automatically find and retrieve application updates, and another for First Aid 95 Deluxe. I've come to rely on both products this past year.

Microsoft Word 7, a big improvement over Word 6.0c, receives the User's Choice Award for word processors, and Dr. Solomon's Anti-Virus Toolkit retains the User's Choice Award in its category.

Traveling Software's LapLink 95 works fine. It will let you remotely access and control your computer over any network, including a modem. It will also transfer files and do all the other things you expect of LapLink. The only real problem with LapLink 95 is that it's hard to set up. It works with the TCP/IP protocol, and that's not what Win 95 (and Windows for Workgroups) sets up by default. Installing TCP/IP with valid addresses for each station can be a chore. If you can get past that, you'll love LapLink 95. I'm giving it a User's Choice Award, but I wish I didn't have to include this warning.

On the hardware side, the User's Choice Award for monitors goes to the ViewSonic PT-810, and the User's Choice Award for high-end modems goes to the U.S. Robotics Courier V.Everything Modem. Unfortunately, U.S. Robotics also gets a Chaos Manor Onion for the absolutely worst important Web site of 1996. The information you want is *there*, but it takes genius, much swearing, and evil and potent magic to extract anything useful from that place.

The Nimantics Orion 8× is heavy, but it's packed with features I like. It has a gorgeous display and a keyboard I can type on, and I use it hard. It certainly deserves the User's Choice Award for portables. A Chaos Manor User's Choice Award goes to Visioneer's PaperPort Vx, an incredibly useful combination of a compact document scanner and OCR software. PaperPort also comes built into a keyboard, called the PaperPort ix.

My favorite—and the recipient of a User's Choice Award—among digital cameras is the Olympus D-300L. It has good optics, very high resolution, and an on-camera view screen that allows me to instantly review what I've just shot; it takes only a second to erase a picture that's not what I expected.

I love the Delorme Tripmate. I wrote about this last month, and there's more on the BYTE Web site. It gets the User's Choice Award as Gadget of the Year.

Text-to-speech programs have become important, as companies try to automate voice mail and information programs. Even more important is speech recognition. Sometimes, I think that at any given time half the people in the nation are stuck with a telephone in their ear as they listen to interminable sets of choices and punch in numbers to navigate a menu tree. Whether it's to order movie tickets, buy software, or report that you'll be late for work, there's a telephone menu in your future.

Or perhaps not. Dragon Systems has come up with a combination speech-recognition program and database that lets you tell the program what you're after. I can't comment on just how good the database part of it is, because I haven't used it; but the speech-recognition engine is superb. I watched the Dragon people test DragonDictate 2.5 for Windows on the floor at Comdex in an extremely noisy environment, and I tried it myself. It works surprisingly well.

I wrote at greater length on the program and its implications in the March Web Exclusive, so it's sufficient here to say that DragonDictate 2.5 for Windows gets a Chaos Manor User's Choice Award.

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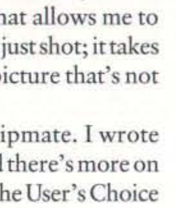
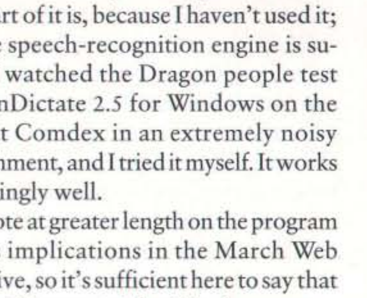

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box system, which was also discussed in last month's Web Exclusive. Actually, this is a shared award: NEC Electronics makes the 64-bit RISC processor, Reality coprocessor, and RAMbus memory that make this thing possible. It's a small game box that attaches to your TV. It has stunning graphics, but what's important is that it can accept memory modules, software as well as game cartridges, and an Iomega Zip drive to serve as mass storage. The result is a system that would be capable of Internet surfing via cable modem. The Nintendo 64 may well be the prototype of the "Internet TV computer" of the future. I'd be surprised if there's not something like this attached to every TV set in the country before the end of the century.

The Game of the Year is MicroProse Software's This Means War, a real-time strategy/tactical war game. I'm usually not fond of real-time games, but this one lets you pause the action while giving orders to all your units, so it's not so much like whack-a-mole as Mindscape's (Novato, CA, http://www.mindscape.com) War Hammer: Shadow of the Horned Rat.

Choosing the game of the year is by no means easy. Very close seconds would be two games from Strategic Simulations (Sunnyvale, CA, http://www.ssionline.com), Fantasy General and Star General, both turn-based strategy combat games. Not far behind them are the same company's Steel Panthers I and II. There's also MicroProse Software's Master of Orion II, which is highly enjoyable. Blizzard Entertainment's (Irvine, CA, http://www.blizzard.com) WarCraft II: Tides of Darkness is excellent. Interplay Productions' (Irvine, CA, http://www.interplay.com) Conquest of the New World (once you download the bug fixes) can enjoyably consume a lot of your time. All in all, it has been a great year for the kind of games I like.

The book of the month is *Not Out of Africa* by Mary Lefkowitz (Basic Books, ISBN 0-465-09837-1). This is a detailed refutation of the "all knowledge comes from Africa, and the Greeks ripped off the Egyptians and then claimed to have invented philosophy, and it's all a big plot" school of modern history. Lefkowitz is a classical scholar, and she politely but firmly takes the Afro-centered histories apart. She also explains why this is important and we all ought to care. I'm nowhere near the classical scholar Lefkowitz is, but where our expertises cross, she's certainly got her facts right; and her logic is impeccable.

The most useful books this year have been Lenny Bailes's *Optimizing Windows 95* (BYTE Books, Osborne McGraw-Hill, ISBN 0-07-882120-7) and Kay Yarbrough Nelson's *Windows 95 Is Driving Me Crazy* (Peachpit Press, ISBN 0-201-88626-X). I find myself using them again and again. Both get User's Choice Awards.

In the learning/reference book categories, I find Que (Indianapolis, IN, http://www.quecorp.com) has computer books on everything from Java to Office 97. The books in their *Special Edition Using* series are not light reading, but they tend to be fairly complete and well indexed.

As usual, there's more at Chaos Manor than I have time or space to write about, and I may have to announce a few more awards next month. All told, it was a very good year, for me and for the industry. **B**

Jerry Pournelle is a science fiction writer and BYTE's senior contributing editor. You can write to Jerry c/o BYTE, 24 Hartwell Avenue, Lexington, MA 02173. Please include a self-addressed, stamped envelope and put your address on the letter as well as on the envelope. Due to the high volume of letters, Jerry cannot guarantee a personal reply. You can also contact him on the Internet or BIX at **jerryp@bix.com.**

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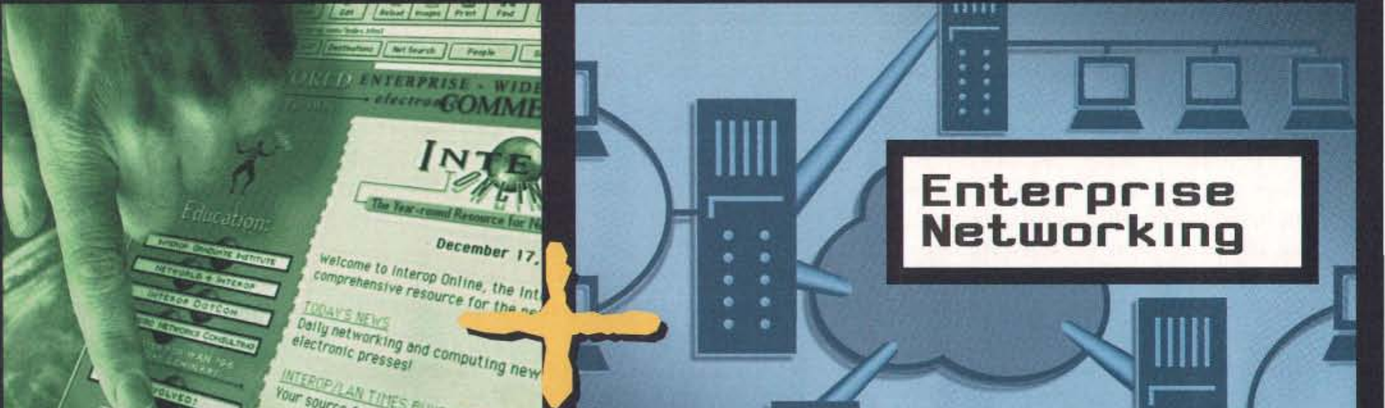

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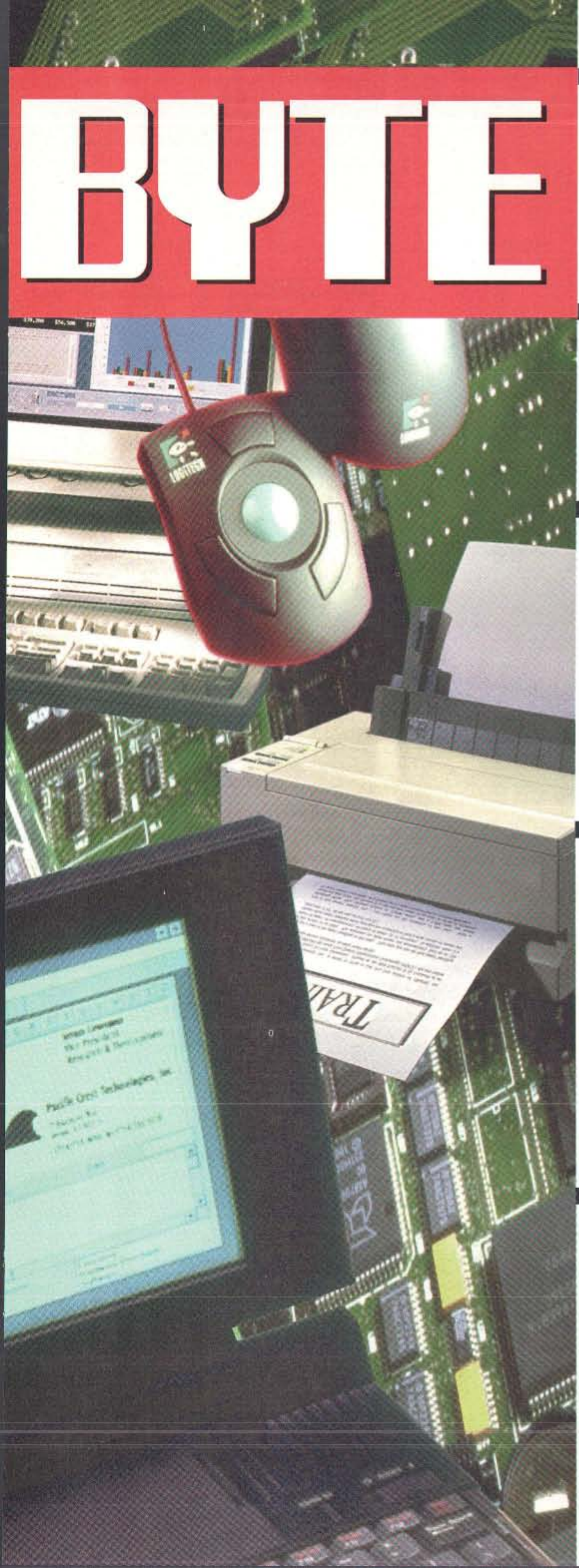

APRIL 1997, VOL. 22, NO.4

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Bravo LC	4Meg/8Meg/16Meg/32Meg	34/69/124/229
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Vectra 500 (EDO, pairs)	4Meg/8Meg/16Meg/32Meg	39/69/99/199
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Aptiva C Series (EDO, pairs)	4Meg/8Meg/16Meg/32Meg	24/49/99/169
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PC 350 Model 6587 (EDO, pairs)	4Meg/8Meg/16Meg/32Meg	24/49/99/169
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PC 750 Model 6887 (EDO, pairs)	4Meg/8Meg/16Meg/32Meg	24/49/99/169
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P/S 2, 53, 53LS, 56, 57	4Meg/8Meg	39/69
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Presario 510, 520, 524, 660, 720, 724, 860	4Meg/8Meg/16Meg/32Meg	24/42/79/159
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Presario 833, 850, 860, 866	4Meg/8Meg/16Meg/32Meg	39/64/119/239
Presario 5528, 7110, 7152	4Meg/8Meg/16Meg/32Meg	24/42/79/159
Presario 7170, 7180, 9536, 9546, 9548, 9564 (pairs)	4Meg/8Meg/16Meg/32Meg	24/42/79/159
Presario 9232, 9234, 9240, 9250, 9642, 9660 (pairs)	4Meg/8Meg/16Meg/32Meg	24/42/79/159
Proliant 1000 5/60, 2000, R, 4000, R (quads)	4Meg/8Meg/16Meg/32Meg	36/62/99/189
Proliant 1500, 1500R (pairs)	4Meg/8Meg/16Meg/32Meg	36/62/99/189
Proliant 4500, 4500R (quads)	4Meg/8Meg/16Meg/32Meg/64Meg	39/64/119/239/599
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Prolinea 575, 590, 5100, 5120, 5133 (pairs)	4Meg/8Meg/16Meg/32Meg	36/62/99/189
Prolinea 5100, 5120, 5133, 5150, 5166 (EDO pairs)	4Meg/8Meg/16Meg/32Meg	36/62/99/189
Prolinea 575E, 100E, 120E, 575MX (pairs)	4Meg/8Meg/16Meg/32Meg	36/62/99/189
Prolinea 590MX, 5120MX (pairs)	4Meg/8Meg/16Meg/32Meg	36/62/99/189
Prolinea 6150E, 6180E (pairs)	8Meg/16Meg/32Meg	69/119/239
Prosignia 300 5/75, 5/90, 5/120, 5/150 (pairs)	4Meg/8Meg/16Meg/32Meg	36/62/99/189
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Armada 4100, 4110, 4120, 4130 (pairs)	8Meg/16Meg/32Meg	69/129/249
Concerto 4/25, 433	4Meg/8Meg/16Meg	49/69/139
Contura 4/25, C, CX	4Meg/8Meg/16Meg	49/69/139
Contura 400C, 400CX, 410C, 410CX	4Meg/8Meg/16Meg	49/69/139
Contura 420C, 420CX, 430C, 430CX	4Meg/8Meg/16Meg/24Meg	49/69/139/199
Contura Aero 4/25, 4/33	4Meg/8Meg/16Meg	49/79/1399
LTE 5000, 5100, 5200, 5300	8Meg/16Meg/32Meg/64 Meg Kit	79/129/249/479
LTE Elite 440C, CX, 4/75CX	4Meg/8Meg/16Meg/24Meg	49/69/139/199
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Canon LBP 860, 1260	–	–	–	19	–	–	39	–	–	69	89	179
Canon LBP4, 4Lite, 4plus	–	–	129	179	–	–	–	–	–	–	–	–
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Epson Action Laser II	–	–	74	–	173	–	–	272	–	–	–	–
Epson 8000, 1800, 4000, 4100, 4300	–	–	89	–	173	–	–	272	–	–	–	–
Epson 1000, 1500,5000,5200	–	–	–	69	–	–	138	–	–	–	–	–
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HP 5L	–	–	39	49	–	–	59	–	–	99	–	–
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IBM Laser 4029, 4037	–	–	–	–	–	–	49	–	–	–	–	–
IBM Laser 4039, 4079	**–**	**–**	**–**	***39***	**–**	**–**	***69***	**–**	**–**	***99***	**–**	**–**
Konica LP-3110, 3115	–	–	89	119	159	–	–	–	–	–	–	–
Lexmark Medley 4C, 4x, 45X	–	–	Call	Call	Call	–	–	–	–	–	–	–
Lexmark, Optra L, LX, R, RX	–	–	–	–	–	–	39	–	–	59	89	169
Lexmark Valuwriter 300,600	–	–	29	39	–	–	89	–	–	–	–	–
Lexmark Winwriter 200, 400, 600	–	–	29	39	–	–	89	–	–	–	–	–
NEC 90, 290	–	–	–	89	–	–	–	–	–	–	–	–
NEC 95, 97	–	–	–	79	–	–	–	–	–	–	–	–
Oki 400	–	–	–	69	–	–	–	–	–	–	–	–
Oki 400E, 400EX, 410E, 410EX	–	–	89	109	169	–	189	–	–	–	–	–
Oki 810E, EX, 600E, EX, 610E, EX	–	–	29	39	–	–	69	–	–	99	129	–
Oki 830, 840	–	–	–	89	–	–	–	–	–	–	–	–
Oki 2350, 2450	–	–	Call	Call	–	–	–	–	–	–	–	–
Panasonic 4420/4450i	–	–	–	79	–	–	149	–	–	–	–	–
Panasonic 4410/4430	**–**	**–**	**–**	***69***	**–**	**–**	***109***	**–**	**–**	**–**	**–**	**–**
Panasonic 4450	–	–	89	–	–	–	–	–	–	–	–	–
Panasonic 4400/5400	–	–	49	69	–	–	119	–	–	–	–	–
Panasonic 4440, 5410	–	–	69	–	–	–	109	–	–	–	–	–
Panasonic 6500	–	–	14	29	–	–	79	–	–	–	–	–
Sharp 9400, 9460, 9600, 9700E	–	–	49	69	–	–	119	–	–	–	–	–
Sharp 9500, E, H, 9700, H	–	–	49	–	–	–	99	–	–	–	–	–
TI Microlaser Pro E, Powerpro, Pro 600	–	–	39	49	–	–	59	–	–	99	–	–
TI Microwriter	–	–	39	69	–	–	–	–	–	–	–	–

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Epson Action Note 800, 866, 880, 910	154
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IBM Thinkpad 365 C, ED, XD	92
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NEC Versa E, V	118
NEC Versa S	$115
Sharp 3010, 3020, 3050, 3060, 3150	185
Sharp 3030, 3040, 3070	136
Sharp 8700, 8800, 8900	160
TI Existensa 450, 455, 510, 515	139
TI Existensa 550, 555, 560, 570	149
TI Existensa 600, 605, 650	181
Toshiba 600, 610	Call
Toshiba 400, 405, 410, 415, 420, 425, 430	193
Toshiba 100, 105, 110, 115, 200, 205	89
Toshiba 2100 Series	89
Toshiba 2400, 2450, 1900, 1950, 1960	109
Toshiba 4700, 4800, 4850, 4900	109
Toshiba T4500, T4600	139

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MODEL	AMT. UPGRADED	PRICE
Tecra 500/P650	***8Meg/16Meg/32Meg/48Meg/128Meg***	***79/129/249/349***
Tecra 700 (SDRAM)	***8Meg/16Meg/32Meg***	***79/139/299***
Tecra 710, 720	***8Meg/16Meg/32Meg/64Meg/128Meg***	***69/129/289/1020/2040***
T2000SXE/2200SX/T1800, 1850, C	8Meg	94.00
T2100, 2105, 2150, 2155, 2110, 2115	4Meg/8Meg/16Meg/24 Meg	49/69/139/199
T4500, C, T4600, T4700, T1900, C, T1910, T1950 (3.3 v)	4Meg	39.00
T4500, C, T4600, T4700, T1900, C, T1910, T1950 (3.3 v)	8Meg	79.00
T4500, C, T4600, T4700, T1900, C, T1910, T1950 (3.3 v)	16Meg/32Meg	139/279
T3400CT, T2400, T3600	4Meg/8Meg/16Meg/24Meg	59/79/149/199
T100, 105, 110, 115, 205, 210	***8Meg/16Meg/32Meg***	***69/129/209***
T400, 405, 410, 415, 420, 425, 430	***8Meg/16Meg/32Meg***	***69/129/209***
T400CS, 400CDT, T100, 105 Edo	***8Meg/16Meg/32Meg***	***69/129/209***
T600, 610, CT Edo, 660	8Meg/16Meg/32Meg	69/129/209

NOTEBOOK, LAPTOP MEMORY

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ACERNote 730C, 735C, 760C, 760CX, 780CX	2Meg/4Meg/8Meg	39/59/89
ACERNote 763, 765, 782, 784, 786	4Meg/8Meg/16Meg	59/79/139
ACERNote Light 350, 352, 355	4Meg/8Meg/16Meg	59/79/139
ACERNote Light 356, 358, 359, 361 (pairs)	4Meg/8Meg/16Meg	59/79/139
ACERNote Nuovo 971, 972	***8Meg/16Meg/32Meg***	***69/125/239***
ACERNote Pro 950, 954, 955, 957, 959 (pairs)	4Meg/8Meg/16Meg	59/79/139
Ambra N Series	***4Meg/8Meg/12Meg/16 Meg***	***89/109/139/189***
Ambra SN Series	4Meg/16 Meg	79/179
Ambra N-75, N-100	4Meg/8/16	49/79/139
AST Ascentia A Series	***8Meg/16Meg/32Meg/64Meg***	***75/139/269***
AST Ascentia P30, P50	***8Meg/16Meg/32Meg***	***89/189/309***
AST Ascentia J10, J30,J50	***8Meg/16Meg/32Meg/40Meg Kit***	***79/159/309/359***
AST Ascentia 900N, 800N, 810, 910	8Meg/16Meg	79/119
AST Ascentia 950	8Meg/16Meg	79/119
AST Bravo & Explorer	***4Meg/16Meg***	***79/219***
AST Notebook Prem Exec 386SX/20/25/25L	4Meg	69.00
AST Power Exec 3/25C, 425EL, 425SL	4Meg/16Meg	69/139
AST Power Exec 4/33SL	4Meg/16Meg	69/139
AT&T Globalyst 130, 200, 250	4Meg/8Meg/16Meg	69/99/149
Austin DX4, DX2, SX2, SX Series	4Meg/16Meg	69/189
Austin Edge	***8Meg/16Meg***	***89/149***
Austin Edge Duet	***16Meg/32Meg***	***199/399***
Austin Vista	***4Meg/8Meg/16Meg/24Meg***	***69/99/219/349***
Canon 1100	4Meg/8Meg/16Meg	Call
Canon Innova Book 150, 175	4Meg/16Meg	59/139
Canon Innova Book 200LS	4Meg/8Meg/16Meg/24Meg	69/99/219/349
Canon Innova Book 350CD, 360, 475	***8Meg/16Meg***	***69/139***
Canon Innova Book 480, 490	***8Meg/16Meg***	***89/149***
CTX EZ Book 5x86 Pent. Series	***4Meg/8Meg/16Meg***	***59/89/139***
DEC HiNote, Ultra HiNote	4Meg/8Meg/16Meg	59/89/139
DEC HiNote Ultra, Ultra II	***4Meg/8Meg/16Meg***	***59/89/139***
DEC HiNote VP 520, 525, 535	***8Meg/16Meg/32Meg***	***89/139/289***
DEC HiNote VP 5100, 5120	***8Meg/16Meg/32Meg/64Meg***	***89/179/399/599***
DEC HiNote VP	***8Meg/16Meg/32Meg***	***79/139/269***
Dell Latitude LM (pairs)	***4Meg/8Meg/16Meg***	***69/99/189***
Dell Latitude 433, C, CX	4Meg/16Meg	69/149
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Dell Latitude LX, M	4Meg/8Meg/16Meg	59/89/139
Dell Latitude XP, XPI	4 Meg/8Meg/16Meg	59/89/139
Epson ActionNote 650, 650c, 660c, 660cx	4Meg/8Meg/16Meg	39/79/139
Epson ActionNote 700, 700c, 700cx	4Meg/16Meg	69/149
Epson ActionNote 880, 866c, 890	4Meg/8Meg/16Meg/20Meg	59/89/159/199
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Packard Bell Statesman	2Meg/8Meg	49/99
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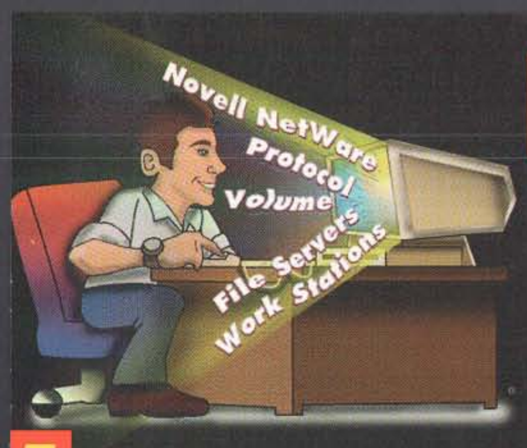

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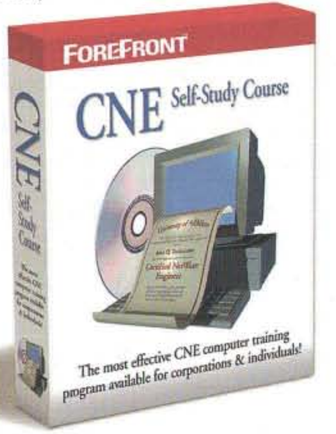
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32MB	243013-001	$228	64MB	243014-001	$456
1MB Video	171017-001	$49			
2MB Video	223335-001	$139			
6MB Video	223336-001	$369			
Deskpro XE 560, 5/66M, 5/60M					
16MB	149949-001	$148	32MB	149912-001	$284
64MB	149913-001	$508	128MB	149914-001	$988
1MB Video	139167-001	$89			
Deskpro XL 450, 466, 560, 566, 5100, 5120, 5133, 575, 590					
8MB	148188-001	$74	16MB	148189-001	$142
32MB	148190-001	$254	64MB	148191-001	$494
1MB Video	139167-001	$49			
Deskpro XL 6150 1050/CDS, 2100/PD, XL 6200 2100/PD					
16MB	210948-001	$481	32MB	228417-001	$375
64MB	228418-001	$851			
2MB Video	223335-001	$139			
6MB Video	223336-001	$369			
Deskpro XE 4100, 433s, 450, 466					
4MB	141684-001	$45	8MB	141685-001	$82
1MB Video	139167-001	$49			
256K Cache	194358-001, 194358-002	$49			
Deskpro 3/25i, 3/33i, 386/25M, 386/33M, 4/25i, 4/33i, 4/66i, 486/33M, 486/50M, 486/66M, 486s/16M, 486s/25M, 486s/33M					
4MB	118690-001	$45	8MB	128877-001	$82
512K Video	141236-001	$39			
1MB Video	139167-001	$49			

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4MB	310-2507	$37	16MB	310-2625	$127
PowerEdge XE, OptiPlex, Dimension XPS, OmniPlex ME 486 & Performance M/L/T Models					
4MB	310-3325	$31	8MB	310-6083	$56
16MB	310-3327	$114	32MB	n/a	$220
Performance ME, OmniPlex Pentium ME, OptiPlex DGX, PowerEdge SP/XE/EL Models					
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32MB	310-3337	$260	64MB	n/a	$462
PowerLine Workstations SE & DE Models					
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Dimension XPS & OptiPlex XL/XM/XMT Pentium Models					
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32MB	310-3375	$260	64MB	310-3368	$462

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16MB	92G7543	$114	32MB	92G7545	$220
1MB Video	92G7443	$49			
256K Cache	92G7251	$79			
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16MB	92G0160	$127	32MB	92G0320	$247
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16MB	92G7204	$127			
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32MB	92G7322	$228	64MB	92G7324	$456
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16MB	92G7204	$127	32MB	92G7205	$247
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LaserJet 5L, 5LFS					
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LaserJet 4, 4M, 4SiMX, 4Si, DeskJet 1200C, 1200C/PS, DesignJet Series					
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LaserJet IIISi, 4+, 4V, 4MV, 4M+, 4P, 4MP, 5P, 5MP, 5Si, 5SiMX, Color LaserJet, DeskJet 1600C, 1600CM, CopyJet					
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16MB	C3146A	$119			
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4MB Exp. Brd.	n/a	$129			
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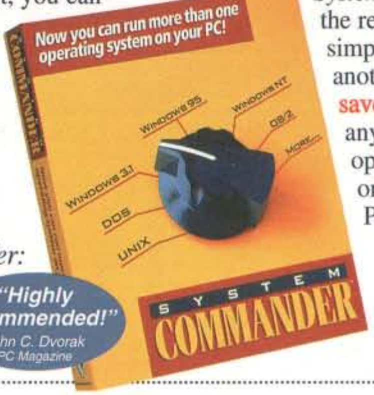

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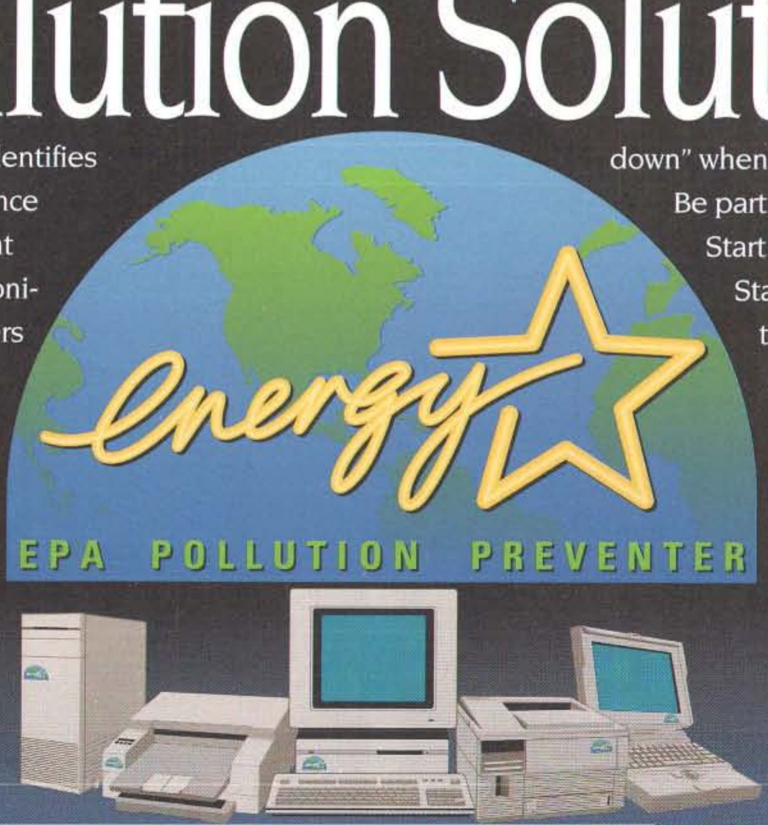

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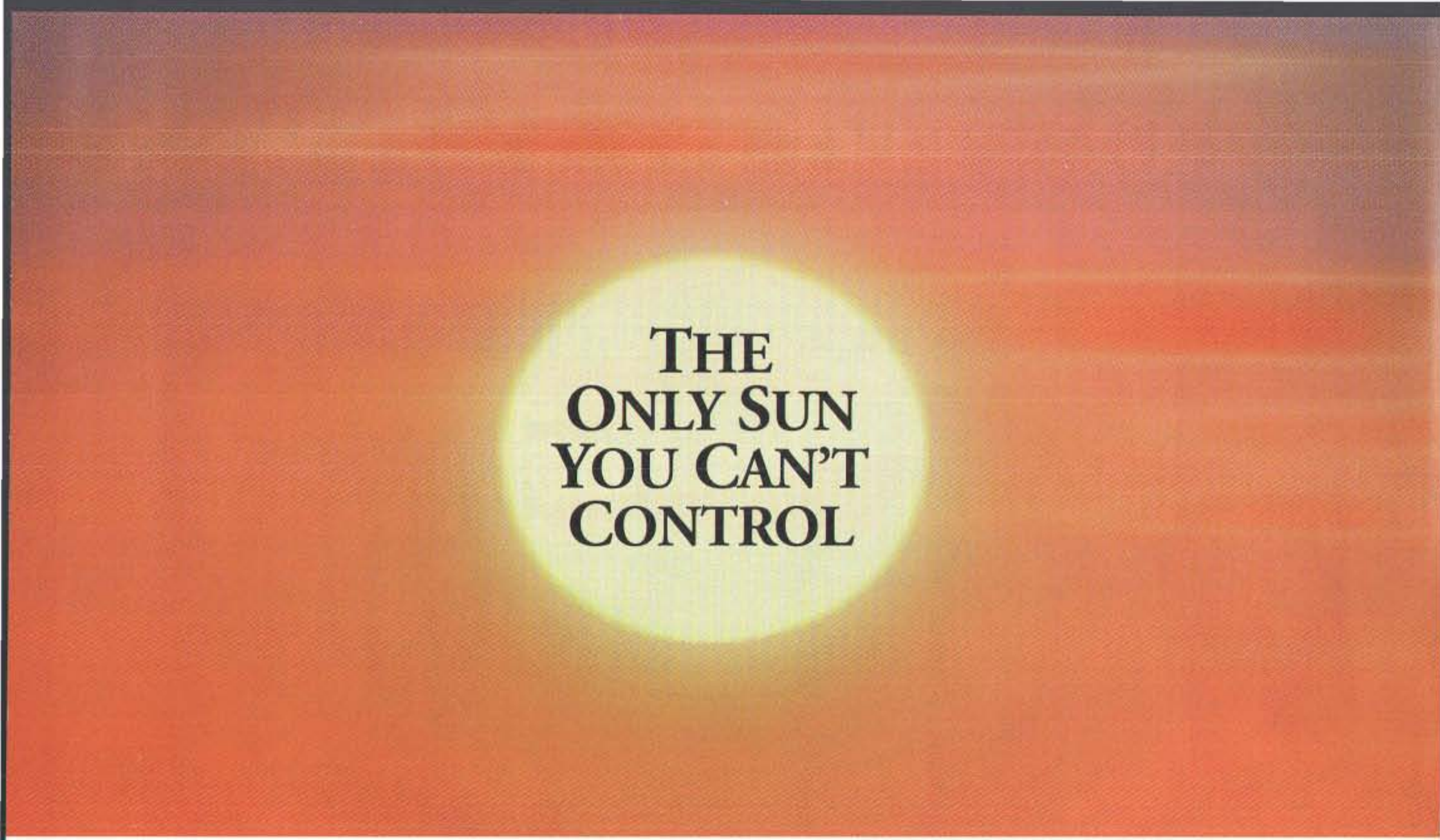

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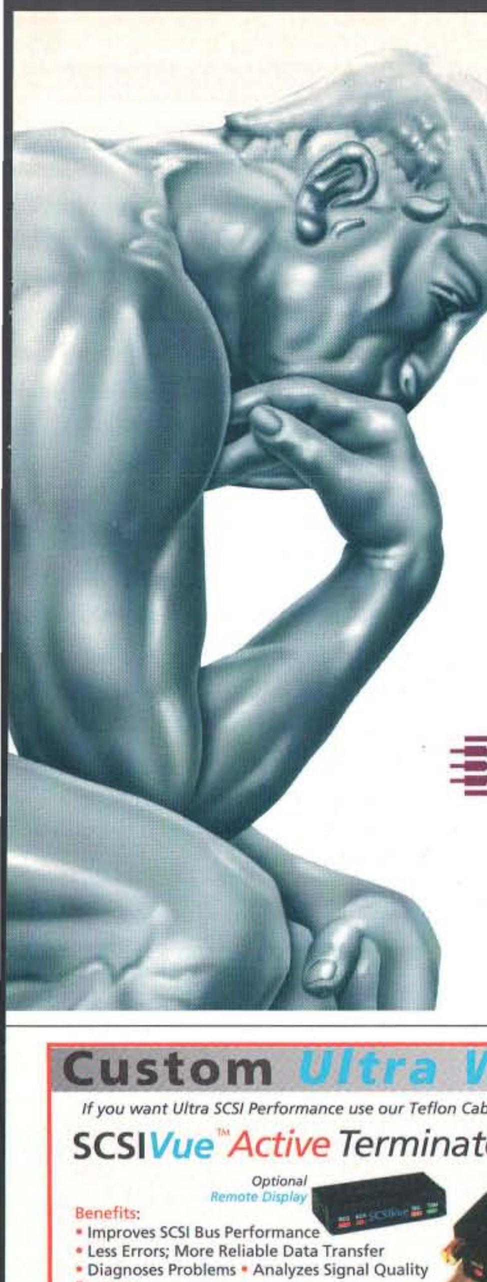

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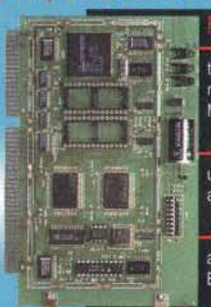

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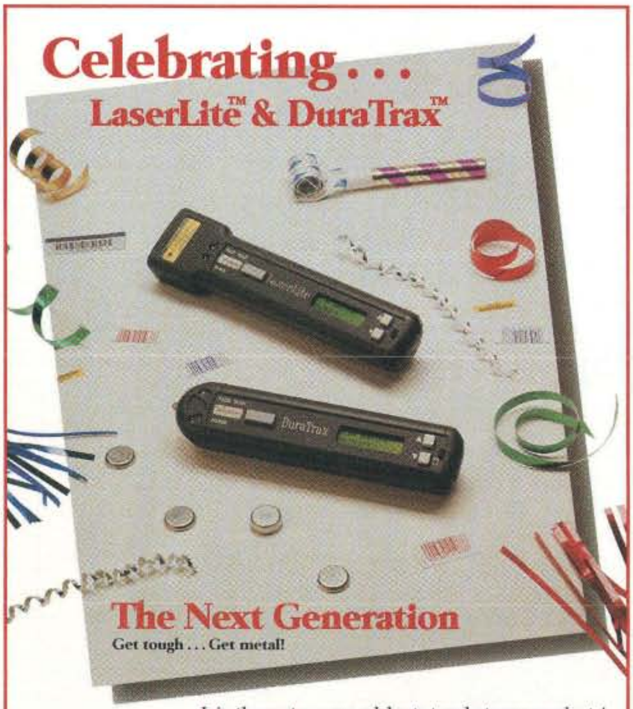

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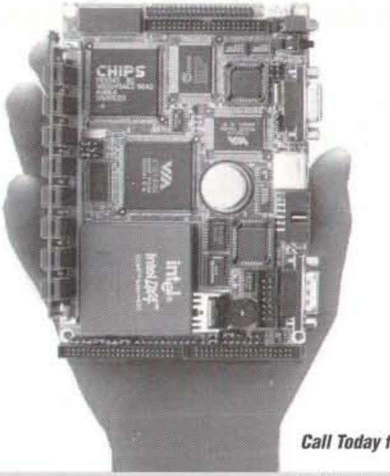

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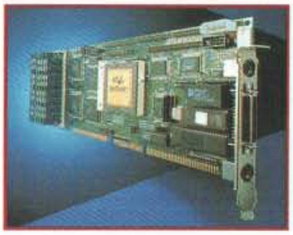

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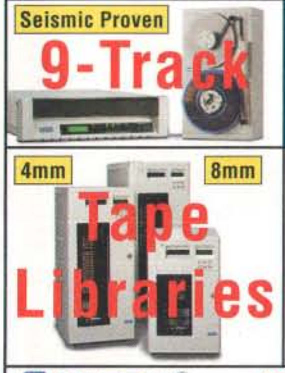

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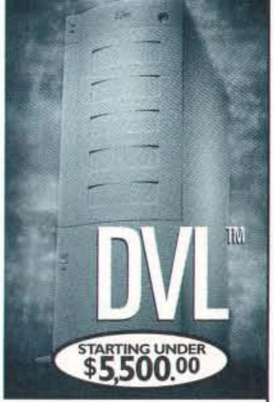

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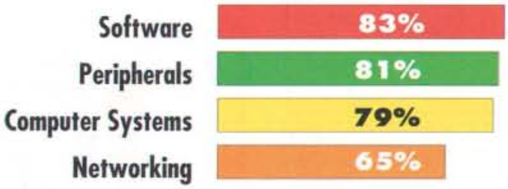

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*	AMERICAN MICROSYSTEMS	**163**	
*	AMERICAN POWER CONVERSION	**32A-B**	401-788-2787
122	AMERICAN POWER CONVERSION	**33**	888-BUY-APCC ext 8074
*	AMERICAN POWER CONVERSION	**64A-B**	401-788-2787
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*	APPLE COMPUTER INC	**2-3**	800-538-9696
111-112	APPRO INTERNATIONAL INC	**164**	800-927-5464
199-200	ARTMEDIA	**92**	+886-2-778-5850
722-723	ATRIE	**40IS 14**	+886-2-999-5155
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192	CARDIFF SOFTWARE	**108**	800-659-8755
157	CENTRAL DATA	**54**	800-482-0397
170-171	CMD TECHNOLOGY	**58**	714-454-0800
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703-704	COMPEX INC	**40IS 13**	714-630-7302
124	COMPUTER DISCOUNT WAREHOUSE	**96-97**	800-959-4239
125	COMTROL CORP	**87**	800-926-6876
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	D		
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162-163	DISTINCT CORPORATION	**150**	408-366-8933
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739-740	FORMOSA INDUSTIRAL COMPUTING I	**40IS 24**	+886-2-226-0840**
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96	NEATO LLC	**167**	800-984-9800
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80-81	QUATECH INC	**162**	800-553-1170
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149-150	ROSS TECHNOLOGY INC	**15**	800-ROSS-YES
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A. Business/Industry: (Check one)

1 ☐ System Integrator, VAR, Computer Service Bureau, Software Planning & Consulting Service
2 ☐ Manufacturer (other than computer)
3 ☐ Finance/Insurance/Real Estate
4 ☐ Education/Medical/Law
5 ☐ Business Service
6 ☐ Manufacturer of Computers, Data Systems Hardware or Peripherals (OEM)
7 ☐ Government: Federal/State/Local
8 ☐ Public Utilities, Communications Systems or Transportation Systems
9 ☐ Wholesale/Retail/Trade
10 ☐ Other (Please specify): ____________________

B. Title/Function: (Check one)

11 ☐ Senior Company Management
12 ☐ Senior IS/IT Management
13 ☐ IS/IT Management
14 ☐ Application Development/Integration
15 ☐ Technical Support Services
16 ☐ Operations/Manufacturing
17 ☐ Systems/Networking
18 ☐ Systems Engineering/Integration
19 ☐ Department Management (non-IS/MIS)
20 ☐ Consulting
21 ☐ Other (Please specify): ____________________

C. Do you evaluate, specify, recommend, purchase: (Check all that apply)

22 ☐ Application Development Products
23 ☐ Networking/Communication Products
24 ☐ Operating Systems
25 ☐ Large Systems (Mainframes/Minis)
26 ☐ Desktops (Micro's/Workstations)
27 ☐ Systems Software Products
28 ☐ Application Software Products
29 ☐ Peripheral Equipment
30 ☐ Telecommunications Services

D. How many people are employed at this location and your entire organization:

At this location		Entire Organization
31 ☐	10,000+	37 ☐
32 ☐	5,000-9,999	38 ☐
33 ☐	1,000-4,999	39 ☐
34 ☐	500-999	40 ☐
35 ☐	100-499	41 ☐
36 ☐	Under 100	42 ☐

E. What is the scope of your purchase involvement?

43 ☐ Company wide
44 ☐ Division wide
45 ☐ Department wide
46 ☐ Individual

April 1997

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1197	1198	1199	1200	1201	1202	1203	1204	1205	1206	1207	1208	1209	1210	1211	1212	1213
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729-730	SPOT TECHNOLOGY	**40IS 19**	+886-2-35-979345
151	STATSOFT	**85**	918-749-1119
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735-736	TATUNG	**40IS 9**	+886-2-592-4569
113-114	TECHNOLAND	**165**	800-292-4500
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100	TERN INC	**167**	916-758-0180
*	THE COMPUTER MUSEUM	**119**	
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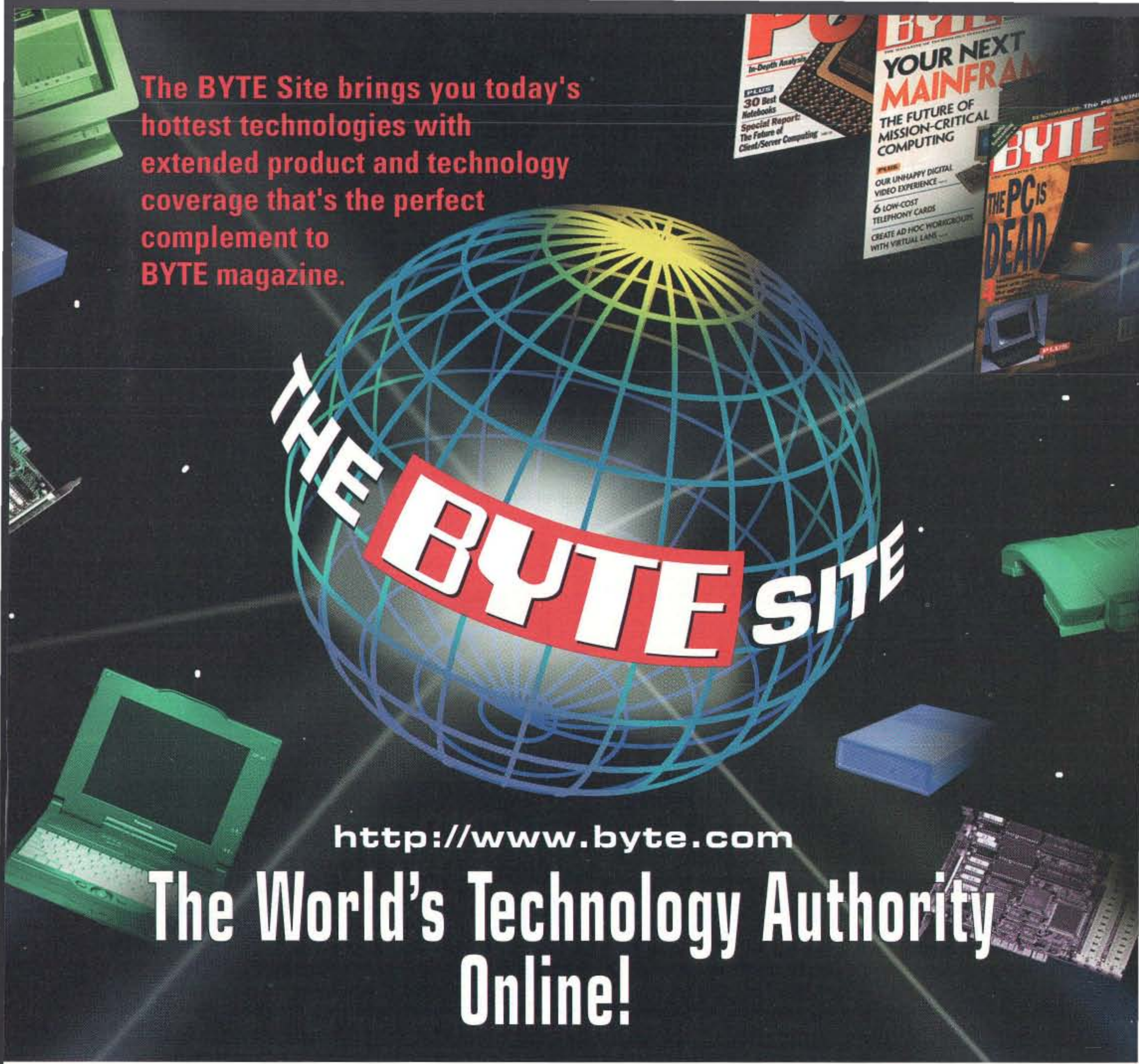
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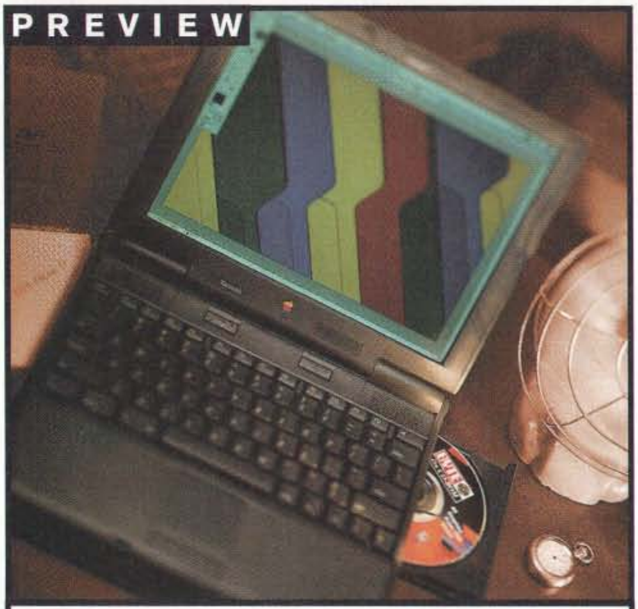

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Faster, Brighter, Better

The above three words sum up the capabilities of Apple's latest notebook computer, the PowerBook 3400. Its PowerPC 603e processor is pumped up to 180, 200, or 240 MHz (depending on the model), and a standard 256-KB Level 2 cache also boosts performance. The base memory of 16 MB is expandable up to 144 MB; hard drive capacities range from 1.3 to 3 GB. A lithium-ion battery powers the system for an estimated 2 to 4 hours. I found this estimate to be accurate with the preproduction unit I tested, which came with a 200-MHz 603e processor, 16 MB of memory, and a 2-GB hard drive.

The 3400 sports a 12.1-inch-diagonal color active-matrix SVGA display that's very bright and crystal sharp. The 3400's expansion bay, where you can hot-dock peripherals, lets you insert and eject a floppy or CDs from the computer's side, which is helpful when you're computing in cramped quarters, such as an airplane seat.

Certain models offer a built-in combination 33.6-Kbps modem/10Base-T Ethernet adapter. I used the modem to get onto the Web by dialing into EarthLink (an ISP) without any problem. I also checked my e-mail and used Apple Remote Access to send and receive articles from BYTE's internal network at 28.8 Kbps.

The PowerBook 3400's one flaw is that it needs to go on a diet: It tips the scales at 7.2 pounds. **–Tom Thompson**

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Contact: Task2, Belmont, CA, (800) 592-3746 or (415) 592-1542.
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Multifunction Keypad Mouse

INCORPORATING A 10-KEY PAD WITH FUNCTION keys and Windows 95 keys, the Super Mouse ($89.95) lets you input numbers and access function keys from the mouse. The device comes with Ctrl, Alt, Tab, Return, Mode Change, and Shift keys.
Contact: RLD Enterprises, Inc., Mesa, AZ, (888) 539-7232 or (602) 503-4668; http://www.supermouse.com.
Circle 999 on Inquiry Card.

Add-In Cards

Wave-Table Sound Card

WITH A PC EQUIPPED WITH THE TIDALWave32 PnP wave-table sound card ($299.95) and software, such as Intel's Internet Phone, you can talk long-distance over the Internet. The card features the 32-Voice Polyphony OmniWave Stereo Synthesizer and 745 philharmonic sounds stored in 2 MB of masked ROM. The package includes AT&T WorldNet ISP software and Voyetra Technologies' Multimedia Essentials Pack.
Contact: Crystal Computer Corp., San Jose, CA, (888) 383-2797 or (408) 383-2100; http://www.crystalcomputer.com.
Circle 1000 on Inquiry Card.

Ethernet Adapter for Pentium Pro Servers

CAPABLE OF ACHIEVING A MAXIMUM AGGREGATE throughput of 800 Mbps, the ANA-6944A card ($998) has four full-duplex ports that automatically self-configure for either 10- or 100-Mbps transmissions. The included Duralink software suite comes with Duralink Failover, which protects servers from network link failures, and Duralink Manager, which provides SNMP and DMI management for monitoring and optimizing server performance.
Contact: Adaptec, Inc., Milpitas, CA, (408) 945-8600; http://www.adaptec.com/networking.
Circle 1001 on Inquiry Card.

PHOTOGRAPH: BRIAN WILDER © 1997

This month we test Apple's PowerBook 3400, which boasts 603e processor speeds up to 240 MHz, and Adobe's PageMaker 6.5, which continues to improve in many ways.

Peripherals

Professional Labels for Your CDs

The Signature CD Color Printer ($1295) prints high-resolution text, logos, graphics, and photographs directly onto printable-surface CD-R media. Using popular Windows or Mac graphics programs, the 24-bit thermal ink-jet printer offers two resolution settings, 300 by 300 dpi and 600 by 300 dpi, and prints up to 16.7 million colors or monochrome. In addition to printing on CD-R discs, Signature lets you print full-color images, graphics, and text onto CD jewel-case inserts.

Contact: Fargo Electronics, Inc., Eden Prairie, MN, (800) 205-5852 or (612) 941-9470; http://www.fargo.com.
Circle 1003 on Inquiry Card.

33.6 SVD Modem with AudioSpan

The AudioSpan Model AM3314IVSP modem ($249) lets you exchange simultaneous voice and data information to other SVD modems when you connect it to an analog phone line. The modem supports V.34/V.Fast Class 33.6-Kbps data transmission and lower speed standards. The full-duplex speakerphone capability provides two-way phone conversations without interruption. When you're on the road, you can set up your PC to automatically answer and record calls, receive faxes, and make data connections.
Contact: Amquest Corp., Lancaster, PA, (717) 569-8030; http://www.amquestcorp.com.
Circle 1002 on Inquiry Card.

Eight-Speed CD-ROM Kit

Now you can add an eight-speed portable CD-ROM drive to your notebook PC. The CD Traveler 820 kit ($399) consists of a CD-ROM drive connected to a proprietary Type I PC Card. The drive has a 600-MB data capacity, a 195-ms average seek time, and a 1200-KBps data transfer rate. You can operate the CD Traveler 820 via your notebook PC's power, the included A/C power adapter, or six AA batteries. The CD Traveler 820S kit ($499) has all the features of the 820 plus built-in 16-bit stereo sound.
Contact: Exp Computer, Inc., Irvine, CA, (714) 453-1020; http://www.expnet.com.
Circle 1005 on Inquiry Card.

Next-Generation Network Scanner

Now workgroups can scan paper-based documents, convert them to electronic form, and send them to one or more recipients simultaneously. The Network ScanJet 5 (for Ethernet 10Base-T and 10Base-2, $2999; for Token Ring and Ethernet 100VG and 100Base-T, $3199) also lets users send information to their desktop PCs, scan the information, and send it through a LAN fax server to an external fax machine. The Network ScanJet 5 supports Windows NT, Novell NetWare, and IBM LAN Server.

Contact: Hewlett-Packard Co., Santa Clara, CA, (800) 527-3753; http://www.hp.com.
Circle 1004 on Inquiry Card.

Full-Page LCD Monitor

The Portrait PageMaster LCD monitor (about $1500) takes up a mere 11 inches on your desktop and offers full-page display of word processors, e-mail, forms-driven databases, faxes, and Web browsing. You can pivot the PageMaster between portrait and landscape views and use the monitor with Windows 3.x, 95, and NT and Mac OS 7.5. The unit displays up to 65,000 colors and supports a maximum resolution of 1024 by 768 pixels.

Contact: Portrait Display Labs, Inc., Pleasanton, CA, (800) 858-7744 or (510) 227-2700; http://www.portrait.com.
Circle 1007 on Inquiry Card.

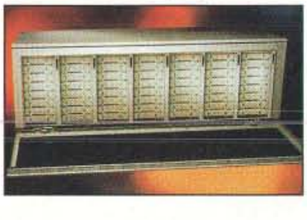
12-ppm Network Laser Printer

Incorporating Kyocera Image Refinement software, which allows for resolutions up to 2400 by 600 dpi, and memory compression technology, the FS-1700 ($1645) comes with a Motorola MC68EC040 66-/33-MHz CPU; 2 MB of memory, upgradable to 66 MB; a 350-sheet paper tray, with options for 1000 or 2000 sheets; 79 resident bitmapped fonts; and 45 LaserJet 4 plus-compatible scalable fonts. The printer supports PC, NetWare, Unix, and Mac environments through optional Ethernet or Token Ring cards and an AppleTalk interface.
Contact: Kyocera Electronics, Inc., Somerset, NJ, (800) 232-6797 or (908) 560-3400; http://www.kyocera.com/printers.
Circle 1006 on Inquiry Card.

Storage

Internet-Based Storage

The LANForce Millennium (from $5995) can collect information from throughout a worldwide enterprise over a direct-to-subsystem TCP/IP Ethernet connection. The subsystem supports RAID levels 0, 1, 0+1, 4, and 5; provides a suite of Internet protocols, including a Web HTTP server, an SNMP agent, a telnet server, SMTP e-mail, and a TCP/IP stack; and delivers dynamic Netscape Navigator– and Microsoft Internet Explorer–compatible subsystem management.
Contact: Procom Technology, Inc., Irvine, CA, (800) 800-8600 or (714) 852-1000; http://www.procom.com.
Circle 1008 on Inquiry Card.



Systems

Workstation-Class Notebook PC

The SparcBook 3TX (from $16,950) incorporates Fujitsu's 170-MHz TurboSparc processor; 256 KB of Level 2 cache; 32 MB of DRAM, expandable to 128 MB; a 10.4-inch active-matrix TFT display; a removable 1.2-GB SCSI hard disk option; a PC Card slot; built-in ISDN; a 14.4-KBps data/fax modem; and onboard Ethernet. The 7½-pound unit comes preloaded with Solaris 2.5 and Tadpole's Notebook Computing Environment.

Contact: Tadpole Technology, Austin, TX, (800) 232-6656 or (512) 219-2200; http://www.tadpole.com.
Circle 1009 on Inquiry Card.

500-MHz Alpha Desktop Workstation

The Carrera Cobra 500's (from $4995) system speed is optimized by a Digital 21164 Alpha chip, 1 MB of synchronous pipelined 9-ns cache, 64 MB of 256-bit RAM with 1 GBps of rendering bandwidth, a 2-GB hard drive, a 12-speed CD-ROM drive, and a 2-D graphics accelerator with 2 MB of RAM. The system comes with four PCI slots (two 64-bit and two 32-bit), two 16-bit ISA bus slots, and two IBM-compatible floppy drive bays.
Contact: Carrera Computers, Inc., Laguna Hills, CA, (800) 476-7472 or (714) 707-5051; http://www.carrera.com.
Circle 1011 on Inquiry Card.

PC/TV Combination

With the ElliVision (from $3195), you can prepare word processing and spreadsheet documents, make presentations, listen to CDs, play computer games, send and receive e-mail and faxes, and browse the Internet. Running under Windows 95, the machine comes with a 100-MHz 486DX4 or a 133-, 166-, or 200-MHz Pentium processor; 16 to 32 MB of RAM; a 256-KB cache; a 1.2-, 2-, or 2.5-GB hard drive; a 1.44-MB floppy drive; a six-speed CD-ROM drive; 64-bit video graphics with 2 MB of RAM; a 27-, 32-, or 35-inch TV/monitor; a 16-bit stereo sound system; a remote mouse and keyboard; a remote programmable control module; a V.34 33.6-Kbps modem; a 14.4-Kbps Group 3 fax; and picture-in-picture capabilities.
Contact: Elli Corp., Ames, IA, (888) 355-4872 or (515) 296-5990; http://elli.global-reach.com.
Circle 1012 on Inquiry Card.

Rack-Mountable 3-D Graphics Workstations

The TDZ-410 RAX (from $16,700) and TDZ-610 RAX (from $23,000) come with dual and quad 200-MHz Pentium Pro processors, respectively, running Windows NT; 128 and 256 MB of memory, respectively; Intergraph's OpenGL RealiZm V25 3-D graphics accelerator; a removable 4-GB hard drive; a CD-ROM drive; and 10-/100Base-TX Ethernet and UltraSCSI connectors. The OpenGL RealiZm V25 3-D graphics accelerator increases the texture-fill rate to 46 million pixels per second to display real-time realistic images at high resolutions.

Contact: Intergraph Computer Systems, Huntsville, AL, (800) 763-0242 or (205) 730-2000; http://www.intergraph.com/ics.
Circle 1010 on Inquiry Card.

SOFTWARE

Antivirus

Antivirus Protection for SMTP Gateways

Norton Internet Email Gateway ($795 per SMTP server) catches and destroys viruses found in e-mail attachments before they invade corporate networks. The Windows NT Server 3.51/4.0 program provides separate and configurable virus-scanning procedures for inbound and outbound traffic; e-mail forwarding and attachment decoding; detailed logging capabilities; and detection of polymorphic viruses.
Contact: Symantec Corp., Cupertino, CA, (800) 441-6054 or (408) 253-9600; http://www.symantec.com.
Circle 1015 on Inquiry Card.

Integrate Antivirus and Backup

The VirusScan Deluxe data-security suite (about $69) provides real-time protection against Internet-borne viruses and includes push-button virus signature file updating and idle-time scanning. The Windows 95/NT product's backup technology provides point-and-click backups to SCSI hard and tape drives, Iomega Zip and Jaz drives, and recordable CD-ROMs. You can also back up your personal data files over the Internet to ftp sites.
Contact: McAfee, Santa Clara, CA, (408) 988-3832; http://www.mcafee.com.
Circle 1014 on Inquiry Card.

Business

Control Document Repositories

The FOLDIR system for Windows 3.1, 95, and NT; the Macintosh; and Unix (from $15,000, depending on the number of users) includes a document-/work-flow system, an off-line browser, Internet compatibility, compound documents, a full-text search engine, OCR support, catalogs, and a document-ownership system. FOLDIR's Change Request System lets you control, monitor, and audit document changes; create change requests on- and off-line; and review and critique documents with multiple simultaneous users.
Contact: Quality Information Systems, Inc., Los Angeles, CA, (800) 953-6264 or (310) 287-0800; http://www.qisinc.com.
Circle 1017 on Inquiry Card.

Build Data Marts

Consisting of three Windows 95/NT clients and two Windows NT Server components, DataStage (from $37,500) lets you extract, transform, integrate, and maintain data from multiple sources. You can browse, import, edit, and create metadata about data sources, user-defined data types, and intermediate tables; schedule and monitor jobs; collect statistics; perform recoveries; and assign resources as needed.
Contact: Vmark Software, Inc., Westborough, MA, (800) 486-9636 or (508) 366-3888; http://www.vmark.com.
Circle 1016 on Inquiry Card.

Engineering

Unite Engineering and the Enterprise

ModelServer Publisher (single-channel version, $9950; multichannel version, $24,500) and ModelServer Continuum ($37,500 per server) are the first two products in Bentley Systems' Engineering Back Office suite for Windows NT. They let you store engineering data in corporate databases, integrate engineering data with enterprise data, and serve Bentley's MicroStation or Autodesk's AutoCAD drawings, maps, and models to enterprise clients, including desktop applications and Web browsers.
Contact: Bentley Systems, Inc., Exton, PA, (800) 236-8539 or (610) 458-5000; http://www.bentley.com/.
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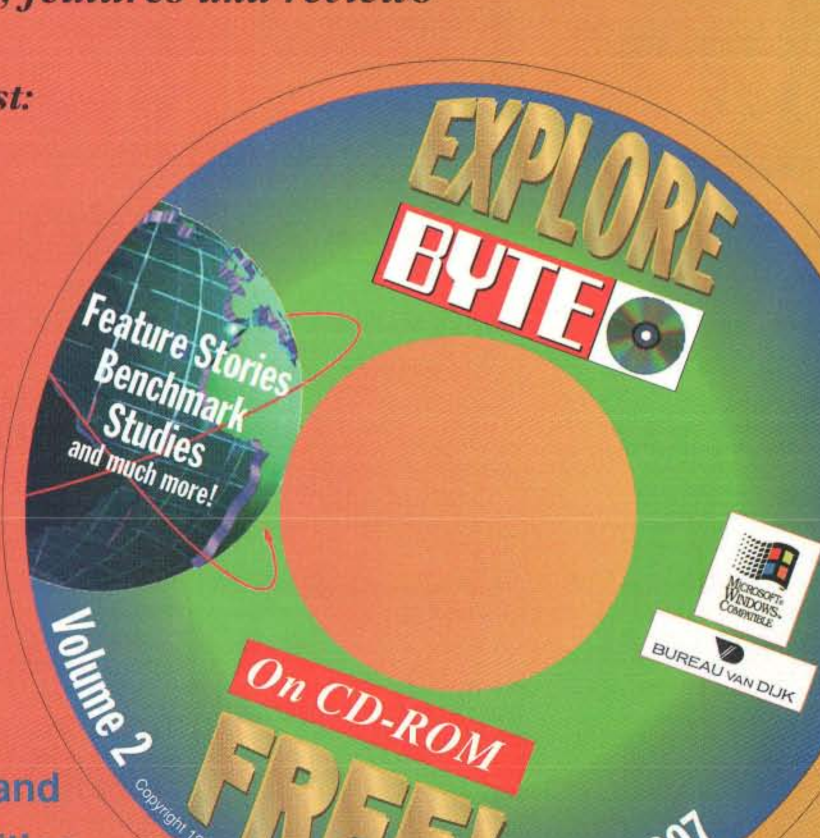

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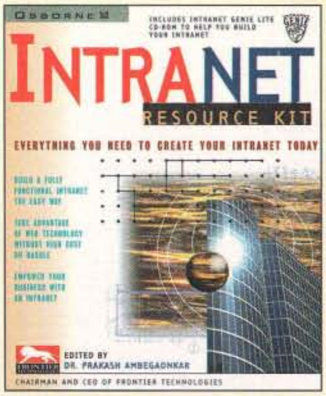
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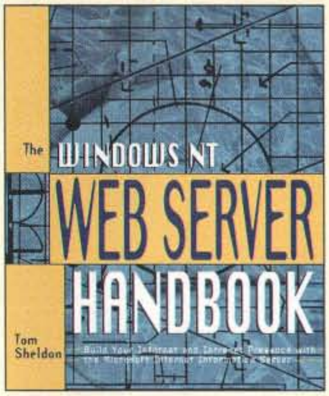

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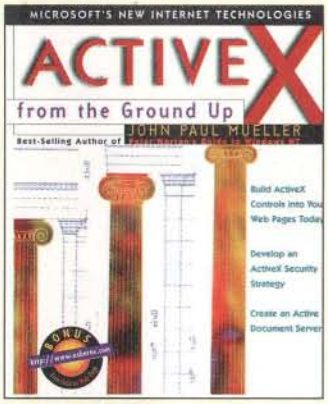
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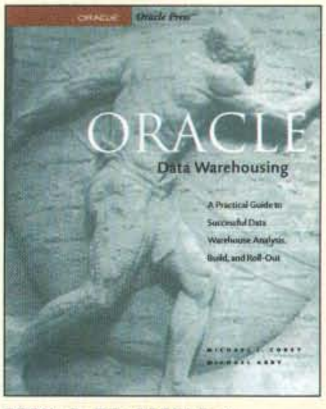
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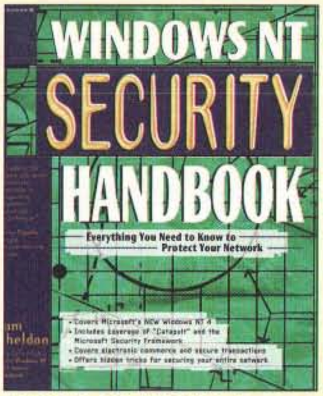

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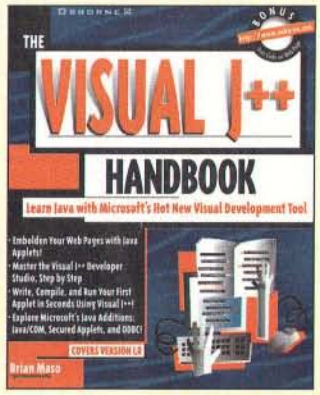

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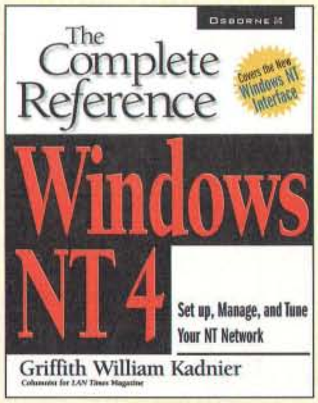

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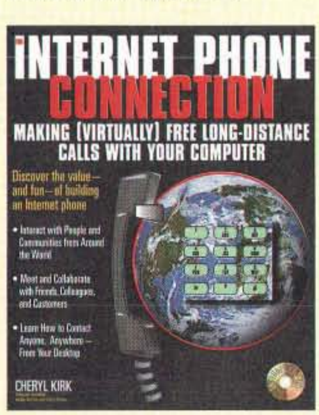
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Wavelet Design and Analysis

The LabView Wavelet and Filter Bank Design Toolkit ($495) is designed for researchers and developers involved in signal and image processing, computer vision, biomedical signals and imaging, physics, and mathematics. For those who don't use LabView, the toolkit includes a ready-to-run application for designing wavelet and filter bank coefficients that you can use in other software applications.
Contact: National Instruments, Austin, TX, (800) 433-3488 or (512) 794-0100; http://www.natinst.com/.
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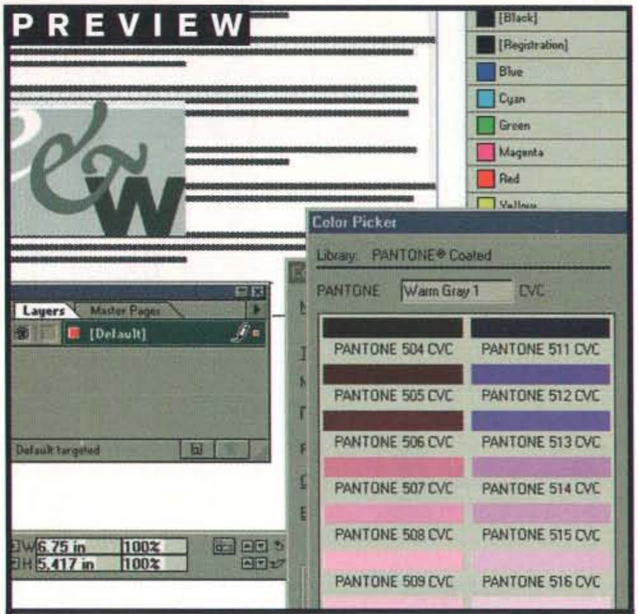

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More Power for Paper and the Web

PageMaker 6.5, the latest incarnation of this venerable page-layout program, serves up improved power, flexibility, and electronic publishing. We looked at a late-beta version of the program for Windows 95 and NT (the Mac version is almost identical).

Layering, perhaps the most impressive and useful feature new to PageMaker, adds flexibility by letting you place objects on discrete layers. You can show or hide specific layers in your final output; changes you make on one layer need not affect the rest of the document.

PageMaker 6.5 lets you redo layouts automatically, saving you time. Now, when you adjust margins, columns, or page sizes, the text and graphics can reflow or readjust automatically to the new specifications. Version 6.5 also adds frames for positioning text and graphics. The frame approach, which many other layout programs support, makes it simple to create document templates and then add text and graphics to the prepositioned frames.

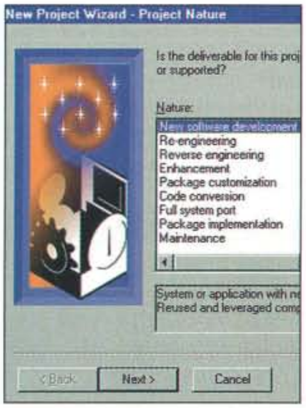
Those who publish to the Web will appreciate the ease of exporting to HTML and the integration with Adobe's PageMill Web authoring tool. There's much more to recommend, including improved toolbars and palettes, better color handling, and improved plug-in support, but the bottom line is that PageMaker 6.5 is a mature and stable program that continues to improve. **–Jon Pepper**

250 Visual Basic Routines

According to MicroHelp, Muscle32's ($199) routines are faster than the equivalent Visual Basic code and perform some tasks that you cannot do in native Visual Basic code. The program includes extensive file and directory services, array sorting, and advanced string manipulation and is compatible with languages that support 32-bit DLL calls, such as Visual Basic and Visual C++.
Contact: MicroHelp, Inc., Marietta, GA, (800) 847-8488 or (770) 516-0899; http://www.microhelp.com.
Circle 1022 on Inquiry Card.

Software Project Estimation Tool

With KnowledgePlan (from $2900), you can plan new, enhancement, or maintenance software projects. The Windows 95/NT program combines a Project Wizard; knowledge-based estimation; what-if analysis; scheduling capabilities; OLE, MPX, and ODBC technology; and Microsoft Access as the working database. KnowledgePlan provides standard reports, run-time Crystal Reports, and custom reports.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Contact: Software Productivity Research, Burlington, MA, (617) 273-0140; http://www.spr.com.
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32-bit ActiveX Controls

A set of seven 32-bit ActiveX controls, ActiveThreed ($139) helps you to create applications with an Internet/intranet look and feel. All seven controls support Microsoft's OCX96 standard and contain Sheridan Property Pages, which let you view or alter graphics, assign properties to a sound file, or adjust an application and then instantly view the result.
Contact: Sheridan Software Systems, Inc., Melville, NY, (800) 823-4732 or (516) 753-0985; http://www.shersoft.com.
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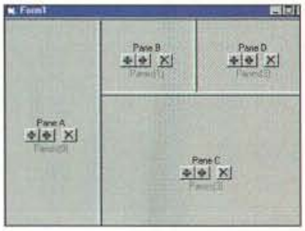

Convert Legacy, Unix Applications

A GUI front-end development tool, TeemCreator (SDK, from $9000) lets you convert legacy or Unix applications to a client/server-style environment. The program supports most popular platforms, terminal protocols, and networks. Once it's installed on the desktop, TeemCreator can communicate with multiple hosts concurrently. Two versions are available: TeemCreator for Windows, which supports Windows 3.1, 95, and NT clients; and TeemCreator X11/Motif, which supports workstations and X Window System terminals.
Contact: Pericom Software, Inc., Hamilton Square, NJ, (609) 588-5300; http://www.pericom-usa.com.
Circle 1023 on Inquiry Card.

WHO DO YOU TRUST WITH THE TRANSMISSION
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Your gall bladder?
A surgeon or some guy fresh from medical school.
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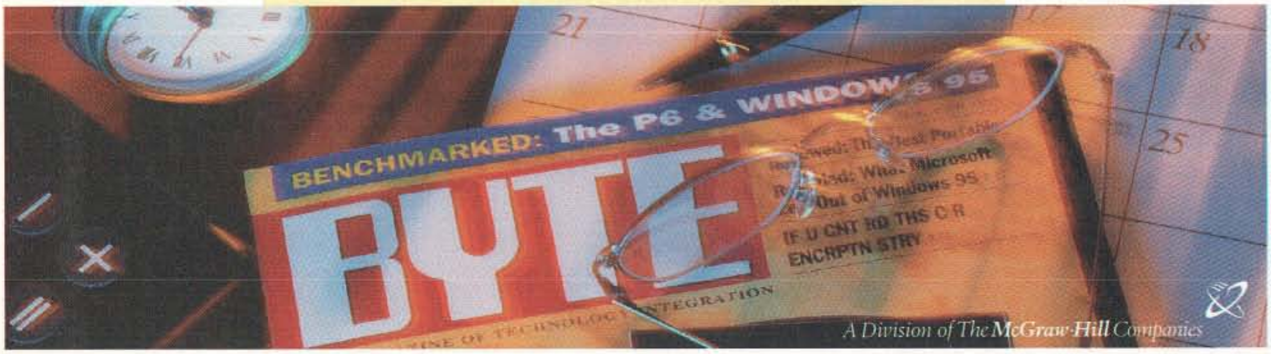
So you get him in your office (he works for you, after all) and say, "Hey, this convergence of computing and communications thing is driving me nuts. You're the technology expert, find me some answers."

And he comes back a month or so later with all the right solutions and products. And you say, "How did you do that so fast?"

And the expert says, "BYTE."

And you wonder how much he knows about transmissions.

∇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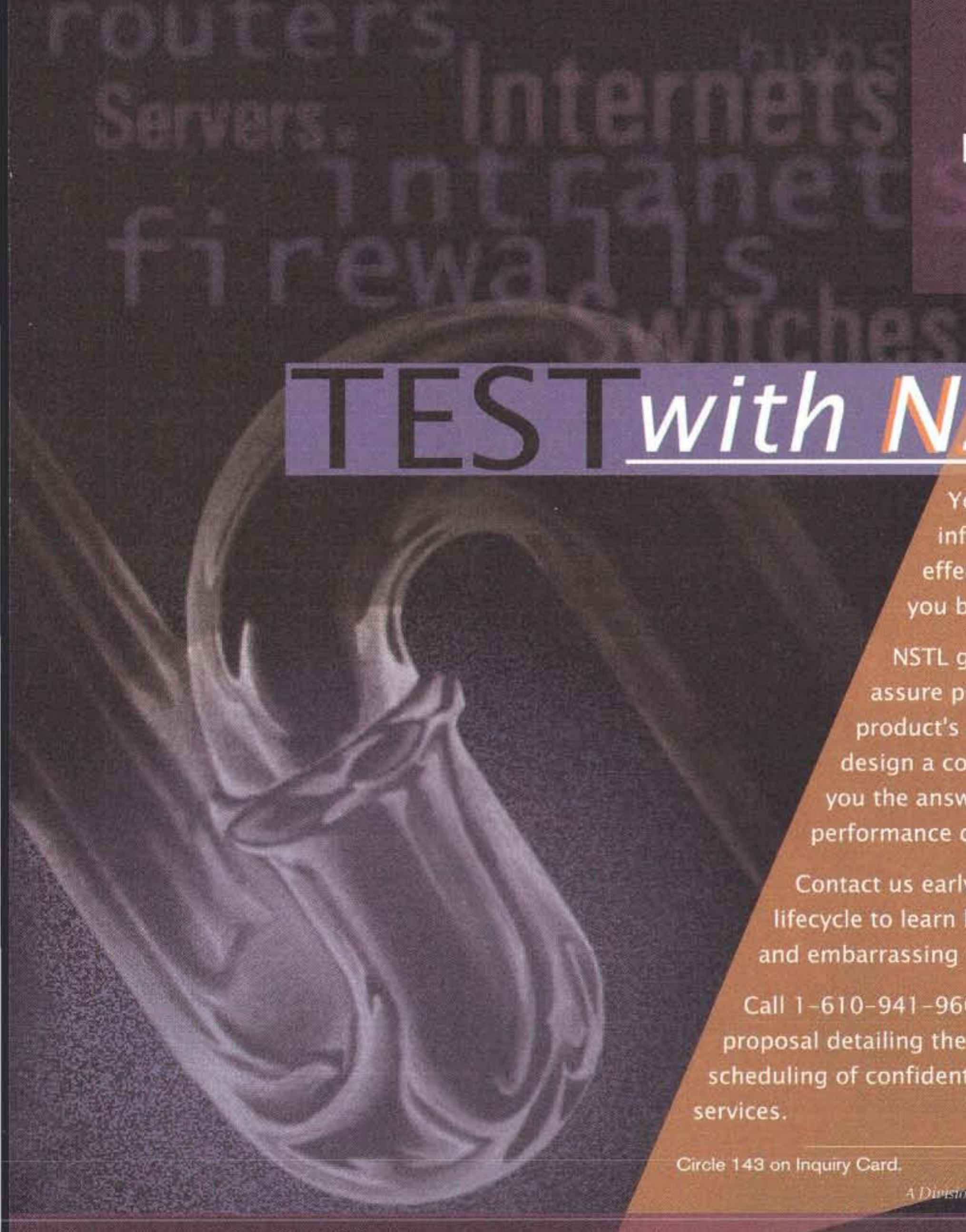

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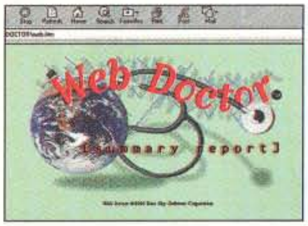
The Web

Web-Site Diagnostic Tool

OPTIMIZED FOR WINDOWS 95 AND NT, Web Doctor ($149) automatically checks all the links of an Internet/intranet Web site and provides a variety of diagnostic reports. The program detects and reports any errors and discrepancies, such as broken links, missing images, suspect pages, and suspect graphics, making it easy to maintain an error-free Internet/intranet Web site. Web Doctor automatically generates a summary diagnostic report of the Web site, as well as easy-to-understand visual reports. You can easily jump from Web Doctor's reports to the files containing errors and fix problems on the fly.



Contact: Blue Sky Software Corp., La Jolla, CA, (619) 459-6365; http://www.blue-sky.com.
Circle 1026 on Inquiry Card.

Stress-Test Your Web Site

WITH ASTRA SITETEST ($9500), YOU CAN stress-test a Web site using a single Windows 95 or NT workstation to spot potential performance problems. You can generate test scripts by accessing the Web application you want to test using Netscape Navigator or Microsoft Internet Explorer. The program also handles Web features that often affect Web server accuracy and performance, such as support for "cookies," proxy servers, user authentication, session IDs, CGI scripts, API calls, and HTML forms.
Contact: Mercury Interactive Corp., Sunnyvale, CA, (888) 932-8378 or (408) 523-9900; http://www.merc-int.com.
Circle 1025 on Inquiry Card.

Software Updates

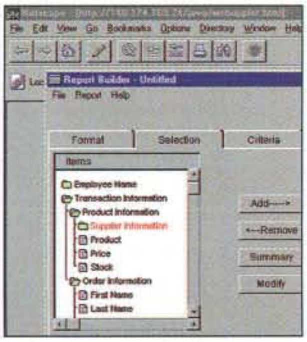
Windows-based client/server software for document and image management, **DocuPact 3.0** provides a single point of access for all enterprise information; indexing, organizing, searching, and security capabilities; productivity tools; Lifecycle Storage Management; and a clustered server environment for unlimited scalability. $700 to $1500 per concurrent user.
Contact: InterTech Information Management, Inc., Atlanta, GA, (800) 671-7272 or (770) 804-8080; http://www.intertech.com.
Circle 1030 on Inquiry Card.

An enterprise application-integration tool, **Prospero 1.5** adds new and improved database, OLE, and Web capabilities; a Task-Based Scheduler; and debugging. Standard Developer version, $695; Professional Developer version, $2395.
Contact: Oberon Software, Inc., Cambridge, MA, (617) 494-0990; http://www.oberon.com.
Circle 1031 on Inquiry Card.

Circuit-simulation software for Windows 95 and NT, Sun SPARC, HP-9000/700, and Silicon Graphics Unix workstations, **T-Spice Pro 4.0** includes a run-time update feature, which lets you view simulation results as they're generated; a multiple-window viewing interface; expression plotting; enhanced noise analysis; new table-simulation features; and a wave-form-smoothing option. From $4495.
Contact: Tanner Research, Inc., Pasadena, CA, (818) 792-3000; http://www.tanner.com.
Circle 1032 on Inquiry Card.

Java-Based Internet/Intranet Reporting Tool

AVAILABLE FOR WINDOWS NT SERVER AND Solaris, DB Publisher (server license, $4195; each additional concurrent user, $95) provides open-standard query, reporting, and analysis tools for use with information in relational databases that you can maintain, upgrade, and administer from one location, even with users scattered worldwide. User access via intranets and the Internet using standard Web browsers is independent of location, database format, and hardware platform.



Contact: Xense Technology, San Francisco, CA, (415) 495-6191; http://www.xense.com.
Circle 1024 on Inquiry Card.

Utilities

Desktop Encryption Utility

PCCRYPTO ($65) LETS YOU SECURE YOUR desktop data and your Internet/intranet e-mail communications. You can send private information to other Windows users, even if the recipients don't have PCCrypto installed. The only requirement of the recipient is a password, which the sender supplies. Once a recipient receives an encrypted PCCrypto file, he or she just double-clicks on the file and enters the password, and the file opens.
Contact: McAfee, Santa Clara, CA, (408) 988-3832; http://www.mcafee.com.
Circle 1027 on Inquiry Card.

Video

Manage Video Information

WITH THE VPRISM VIDEO COMPUTING Suite ($16,500 per seat), you can store and manage thousands of hours of video; annotate your video with notes, numbers, and transcripts; and query your video collection to find specific items of interest, examples, spoken utterances, notes, subjects, or events. The program also enables you to analyze your video and consolidate multiple taped sessions into a single project view and collaborate with your workgroup on projects or specific video content. The product, for the Macintosh and Windows 95 and NT, is configurable as a stand-alone desktop system or can be used in a networked client/server configuration.
Contact: Digital Lava, Inc., Los Angeles, CA, (310) 470-1149; http://www.digitallava.com.
Circle 1028 on Inquiry Card.

Windows CE

Forms-Based Data Collection

DESIGNED FOR THE MOBILE DATA-COLLECTION and corporate intranet user, the AllPen Mobile Forms Database ($79) allows you to create your own forms without the need for a desktop application. You create custom forms on your Windows CE device, defining field types and entering preset default responses. Field types can include text, notes, numbers, pop-up menus, radio buttons, and checkboxes.
Contact: AllPen Software, Inc., Los Gatos, CA, (408) 399-8800; http://www.allpen.com.
Circle 1029 on Inquiry Card.

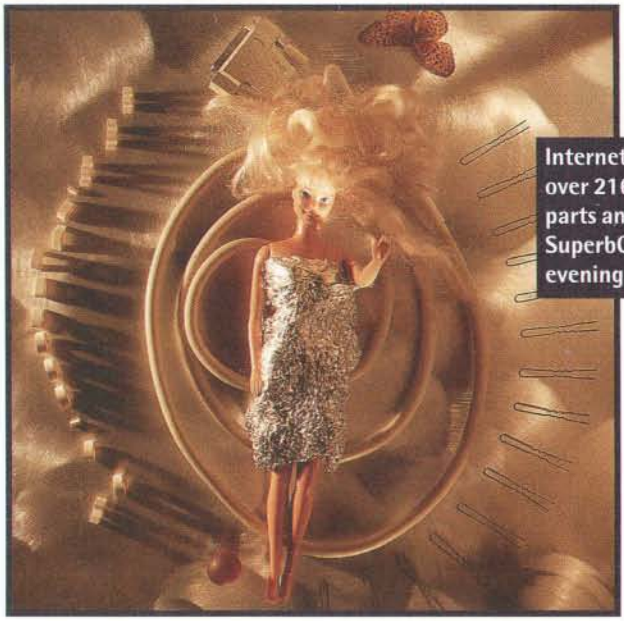
Marc Abrahams

improbable

Internet Barbie dolls ◆ a new threat to data warehouses ◆ a request for heaps of quality

Advances and Retreats in Computing

Internet Barbie



Internet Barbie has over 216 million parts and a SuperbConductive evening wrap.

This is Internet Barbie. Two specimens currently exist. One, the very same whose photograph keeps you from tearing your eyes away from this page, is on display in the Museum of Improbable Research, at Harvard University.

The other Internet Barbie is preserved inside a small time capsule that was buried at MIT in 1994 to honor the turn of the century of centuries. In response to our request then for ideas about whom/what we should bury to best capture the essence of the late twentieth century, a gentleman named Donald Turnblade proposed a symbol embodying the interconnectedness, human nature, character, and intellect of the Internet: a half-naked Barbie doll with fiber-optic cables instead of faux flaxen hair.

We have eliminated the half-nakedness in deference to various government initiatives regarding obscenity and fun.

Now, Internet Barbie is cloaked in a modest, protective yet provocative, stylish and sincere, SuperbConductive™ tinfoil evening wrap.

Internet Barbie took form in the dead of night in our laboratory in Cambridge, Massachusetts. The design/manufacturing team used contents from a dumpster (notably a preowned conventional Barbie doll) and an armamentarium of used computer parts. Internet Barbie contains more than 216 million parts, nearly all of them microscopic, the vast majority of which are dust particles or bacteria. The cable is standard issue, pilfered from Radio Shack. Internet Barbie is as Mac-compatible as she is PC-compatible.

Now, we hereby announce the Internet Barbie Design Contest. With the millennium comes a need for a new, improved Internet Barbie design. Please construct your candidate for Internet Barbie Mark 2000, then send us a photograph. You may ship us the actual device, but please do not expect to get it back. The winner will receive a genuine 1.4-MB blank disk, a hearty handshake (which you must track us down to receive), and a letter of commendation.

New Warehouse Pest: Data Moths

Readers tell us that data cleansing and coordination among various departments are two of the most difficult challenges in a data warehouse project. But a new, frankly distasteful, problem has emerged for keepers of data warehouses: data moths.

Problems associated with data moths include chewing of disks, tapes, and other media. A data moth infestation can turn a clean, tidy data warehouse into a big, sad, lonely closet filled with miscellaneous frayed bits and bytes and messy, dropping-encrusted index tables and gigaboxes. Database administrators report they have returned rested and tanned from vacation, only to face row after row of half-empty data hangers, some holding nothing more than woolly strings and rusty old pointers.

Quality Contest

We are sponsoring an ongoing Quality Contest. The purpose is to constructively combine two facts of modern life: One, we are all expected to spend our working hours immersed in quality; and two, if you keep your boss immersed in quality, you will be free to finish your work.

We therefore announce a technical essay contest. Each month, or whenever we feel like it, we will have a new contest. This month's challenge: define a technical specification for a database to inventory, manipulate, and analyze large quantities of quality. Entries are limited to a maximum of 100 words. The winner will receive a free subscription to our new publication, *NanoQuality*, if we ever publish it.

Marc Abrahams is the editor of The Annals of Improbable Research. *You can reach him at* **marca@improb.com.**

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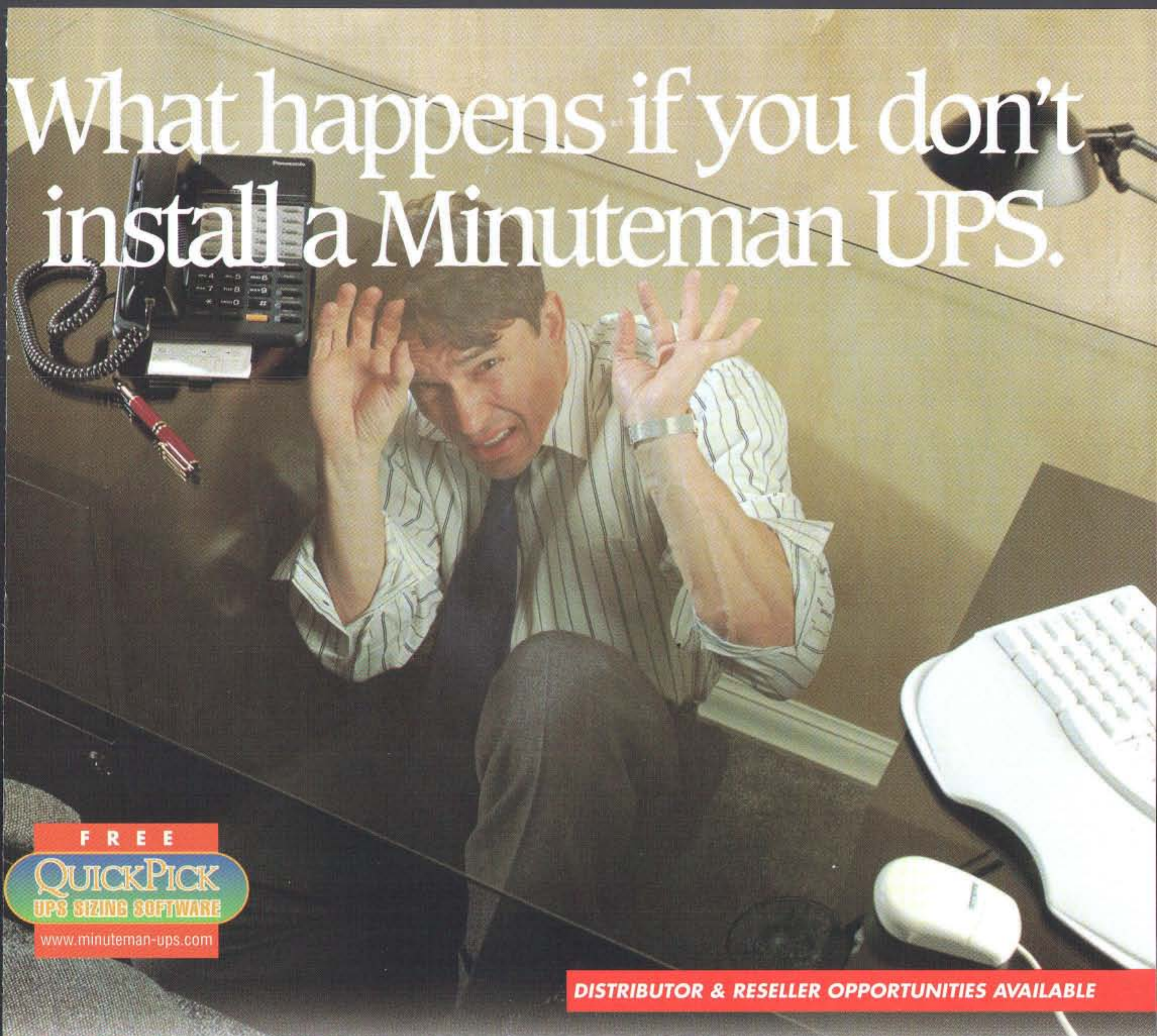

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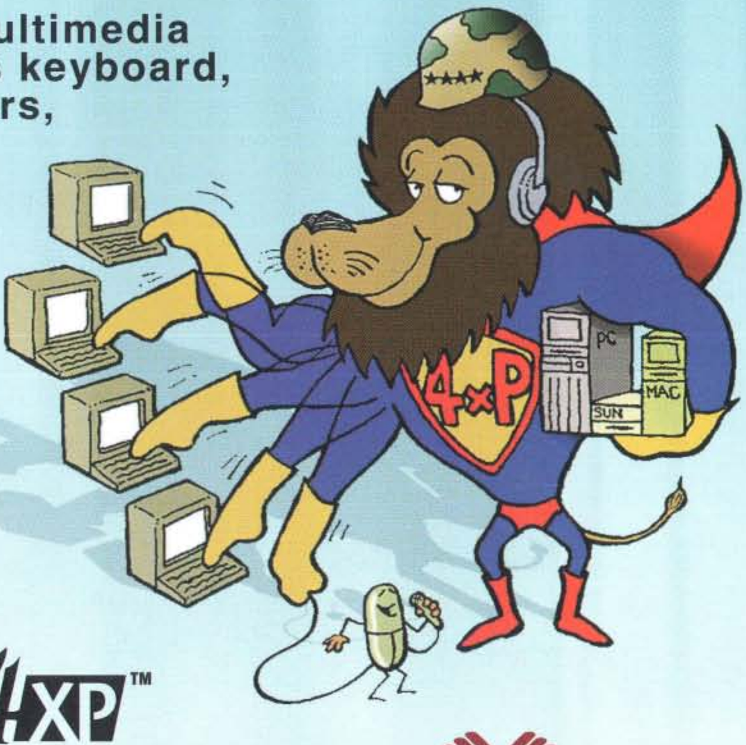

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